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COMPRESSED AIR MAGAZINE

DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

Vol. xv SEPTEMBER, 1910 No. 9

Compressed Air is conceded to be a force more flexible and more useful to modern high-speed mechanical operations than any other excepting electricity. In many shops and factories it is more important than steam itself.

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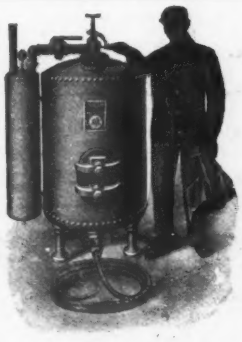

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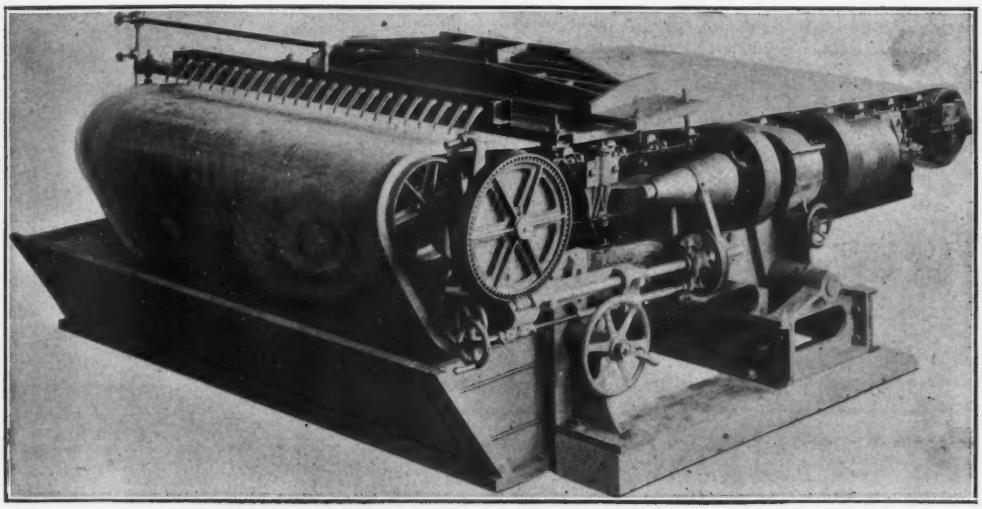

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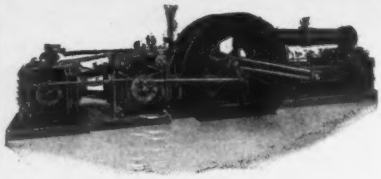

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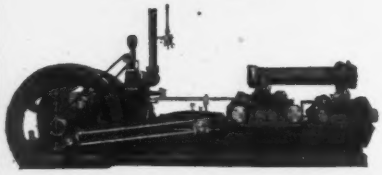

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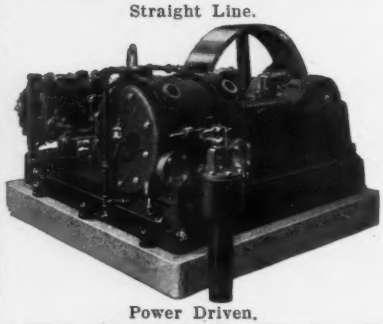

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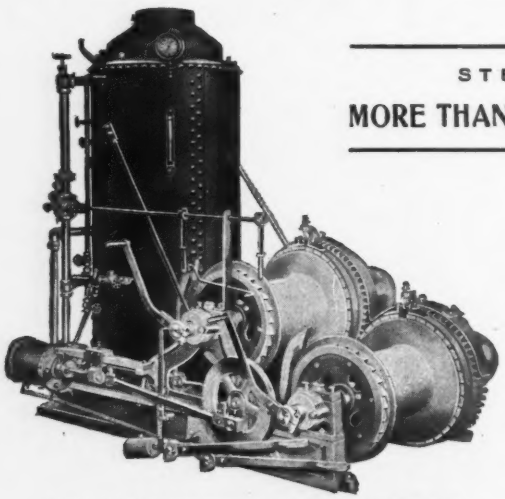

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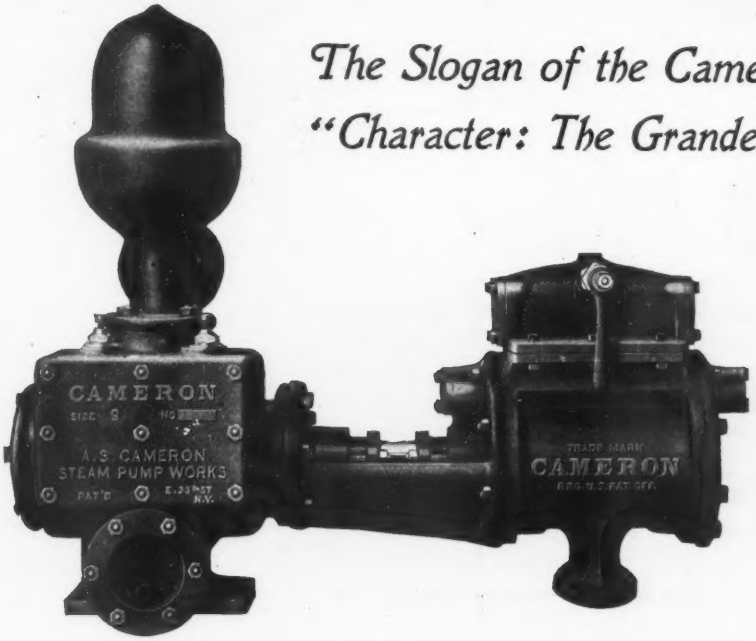

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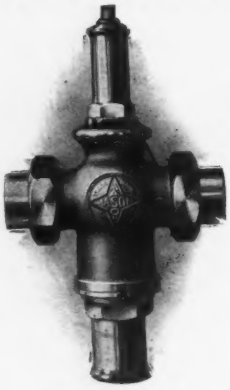

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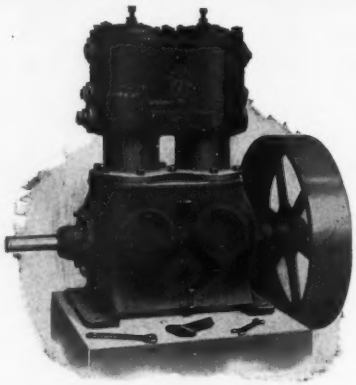

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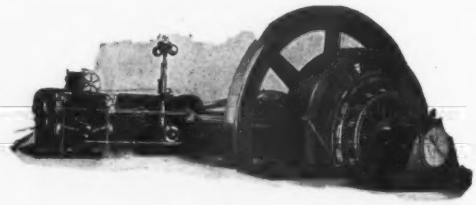

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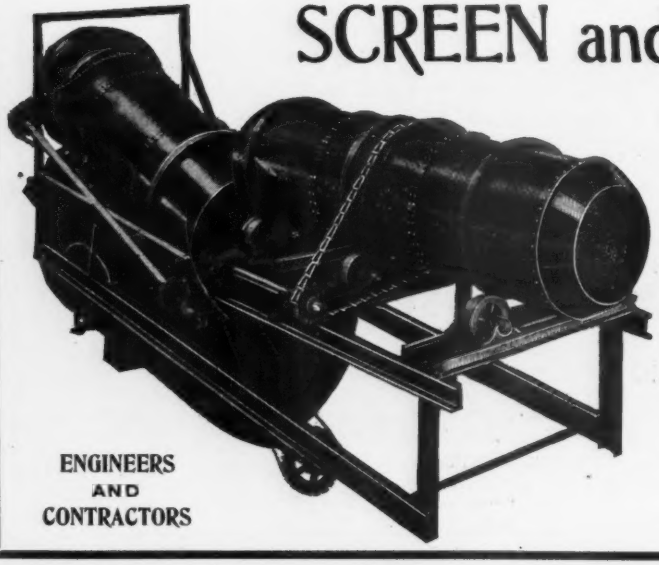

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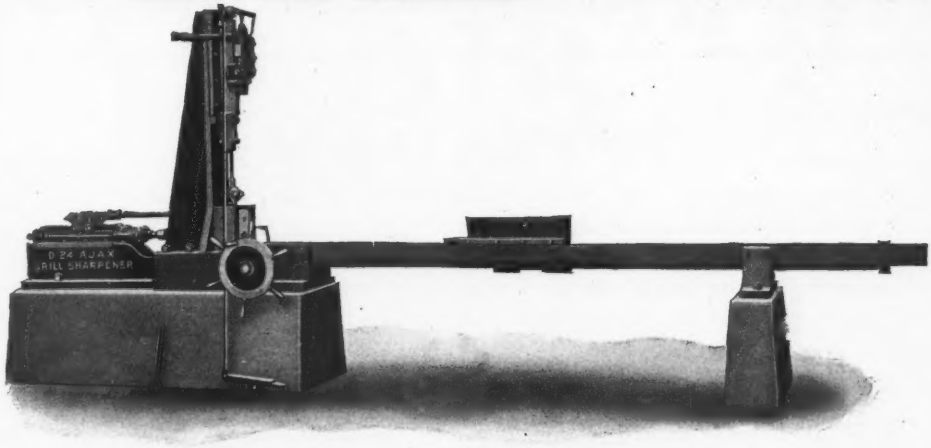

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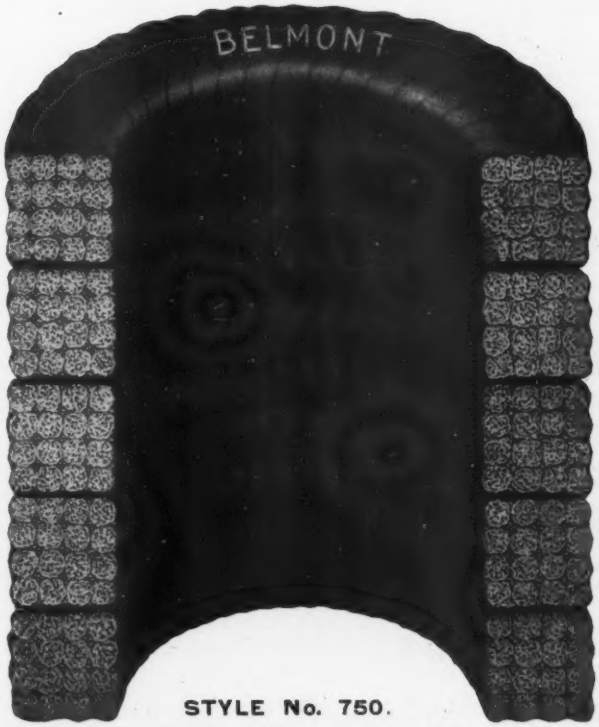

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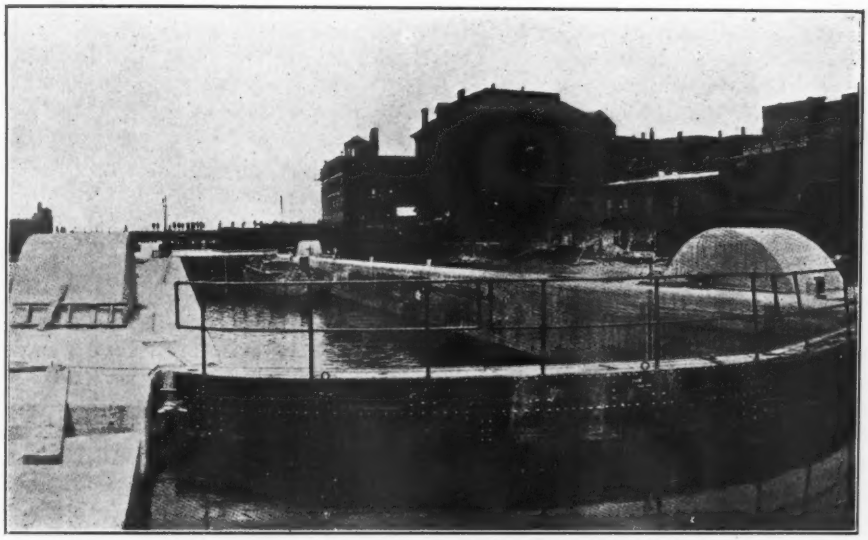


SIPHON LOCK ON THE BARGE CANAL.

THE SIPHON LOCK ON THE NEW YORK STATE BARGE CANAL

In the city of Oswego, and standing at the head of the harbor which has been formed where the waters of central New York discharge into Lake Ontario, has been constructed a canal lock of interesting pattern, the only example of the siphon lock on the Barge canal, the first of the type to be built in this country and the largest in the world using the siphon principle. The following description of this interesting lock is taken from the July issue of the *Barge Canal Bulletin.*

In the locks of the type used elsewhere on the Barge canal the chambers are filled and emptied through culverts running inside the walls, having the necessary side openings, entrances and outlets, and placed so that the water will run through them by the action of gravity, or, in other words, so that it will always run down hill. Near the upper and lower ends of these culverts are placed large steel valves which move up and down in slots in the walls. Each of these valves rolls on four wheels attached to its framework, and is rectangular in shape and slightly larger than the culvert it closes. Near the top of the wall counterweights are provided, together with cables and machinery for pulling up and letting down the valves.

With a lock of the siphon type the general design of the culverts is similar to that of a lock of ordinary type, except that at the upper and lower ends the culverts are curved up so as to make necks, which rise a little way above the highest water level and which at the

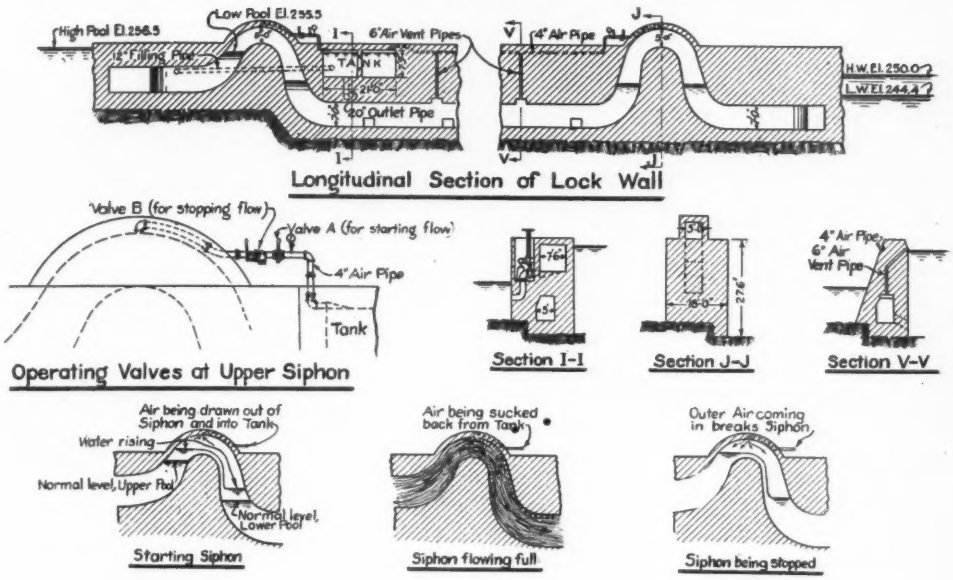
same time are shut off from all communication with the outer air, except through the operating pipes. These necks are shown on the accompanying drawing. While the lock chamber is filled and emptied by water operating under the action of gravity, the flow is modified by siphonic action. All the water flowing into or out of the chamber runs uphill and over the crests of the siphons, lifing itself over the top of the lock walls before it begins to run down into the lower levels of the culverts.

The first lock of this type was completed about 1896, on a canal in northern Germany, and was designed by Professor Hotopp, of Hanover. As its operation proved to be simple and successful, the remaining six locks on this canal were also made of the siphon type and others have been built here and there in Germany since that time. The chief advantages which they possess are those of simple and cheap operation and maintenance, as there is no complication with machinery or motors, and no large culvert valves to be operated under water, but all the movements are made by direct action of the head of water on the air pipes and are controlled by hand valves, all parts being easily acessible and simple in design. The head of water moreover, not only supplies the motive power, but automatically renews it during each operation. Deterioration of steel work under water by rusting is also eliminated, and in the case of the lock at Oswego it was found that the siphon type was the more economical as compared with the design which would have been used for a lock of ordinary type at the same site.

Looking at the drawing, it will be noticed that at the upper end of the wall there is a space marked "Tank." This is a space 7½ ft wide, 7¾ ft. high and 21 ft. long, with a center partition, built in the wall and communicating by means of pipes with the upper and lower levels and with each siphon in the same wall. One of these tanks is provided at the upper end of each lock wall and each one is entirely shut off from communicating with the outer air, except through the pipes and through a manhole with an airtight cover. One pipe, 12 in. in diameter, is used to fill the tank; another pipe, 20 in. in diameter, is used to empty it, and the remaining two pipes, each 4 in. in diameter, are connected with the siphons and used for the operation of the lock. The cubic contents of the tank are nearly half as much again as the contents of one of the siphons, measuring from low pool levels at the lock.

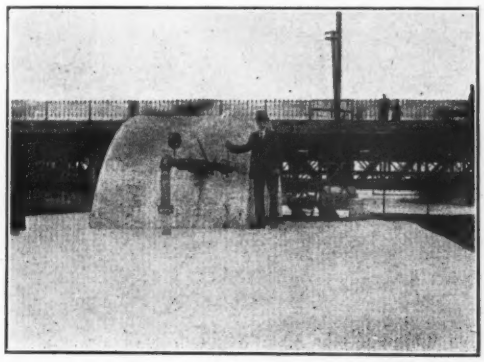
The operating power for filling or emptying the chamber is obtained as follows: The 12-in. pipe for filling the tank is first opened, the 20-in. emptying pipe, of course, being closed. The water from the upper pool then rushes into the tank, the air escaping through the valve marked *B*. This necessitates, of course, that the valve marked *A* should be open also. During this operation the neck of the siphon is temporarily in communication with the outer air, but as there is no drawing tendency of the air, the level of the water in the siphon does not change. The air escapes through the pipe with considerable force, and the tank is filled in about 4 minutes from the time of beginning to open the 12-inch valve. This valve, together with the controlling valves "A" and "B," is then closed, and it must be seen, of course, that the corresponding valve "A" at the lower end of the lock also is closed, thus cutting off communication between the tank and both its siphons. On opening the 20-inch outlet valve there is produced in the tank the effect of a body of suspended water tending to escape into the lower pool. As the tank is now shut off from all communication with the outer air, the water remains suspended by its weight and thus produces the vacuum necessary for operation. For the convenience of the operator a vacuum gage is placed at each siphon, so that he can tell how much operating power is available. During the filling of the tank the needle of the gage stands at zero, but as soon as the filling is completed and the opening of the 20-inch valve has begun, the needle begins to move slowly upwards, stopping finally at the difference in head between the upper and lower pools. This, as is usual with vacuum gages, is indicated in inches of mercury. The average head under which the lock will operate will be 8 or 9 ft., and would be indicated by a reading of about 7 to 8 in. on the dial.

With the tank filled and the outlet valve open, everything is ready to start the flow of water. This takes place as follows: Suppose it is desired to fill the lock. The valve *A* stands closed and the valve *B*, which communicates with the outer air, must also be closed. Valve A is then opened and the air in the siphon rushes into the vacuum in the tank displacing part of the water in the latter and permitting it to escape into the river through the 20-in



SKETCHES SHOWING ACTION OF SIPHON

outlet. Reference to the drawing will show the manner in which the water rises in the siphon. After it has reached the crest it begins to flow over into the culvert below. The tank continues to draw out the air, and as soon as the water in the siphon has risen to about one-third of the height between the crest and the crown, equal in this instance to a little less than 2 ft., part of the air begins to be carried out through the culvert, and the siphon thereafter fills itself automatically. All the foregoing action takes place rapidly, and under an 8-ft. head the siphon begins to prime itself in from 30 to 40 seconds. At this time the needle of the gauge, which recedes several inches as soon as valve *A* is opened, begins to climb again, and the siphon at the same moment reverses the action of the tank, so that instead of the air being drawn into the tank, the siphon begins to draw it back from the tank and to carry it out into the culvert. A certain amount of water from the river flows up into the tank at the same time through the 20-in. outlet pipe and supplies the place of the air, so that in a few minutes after valve A has been opened the original vacuum is restored in the tank. The movement still continues, however, and only stops when the tank and the pipes have all been drawn full of water, at which time the needle usually registers 3 or 4 in. more of vacuum than at the time of starting. Some experiments were made with a float gauge in the tank to ascertain the rise and fall of the water, and it appeared that when the reversing action began, the operating head of water in the tank was nearly 2 ft. in excess of the head in the siphon. It would have been expected, therefore, that the tank would have continued to draw air out of the siphon until this head was neutralized, but in point of fact the draft of the siphon was so strong that it not only overcame this differ-



LOWER SIPHON AND VALVES.

ence but drew water into the tank, thus filling it again completely.

The air which is carried out by the water escapes partly in small bubbles through the culvert ports, but chiefly through the air vents in the walls, shown on the drawing. At first there is a discharge of mingled air and water, which is thrown a few feet from the lock wall, but as the flow through the siphon increases, the jets also increase until they occasionally blow a cloud of spray 50 or 60 ft. If this discharge should at some time cause inconvenience to boats, it will probably be remedied by cutting recesses in the walls and bolting baffle plates in front of the pipes. Practically all the discharge of air takes place through the upstream vents and the culvert ports and only a small portion reaches the lower vents.

With both siphons in use the lock chamber can be filled in 4½ to 5 minutes, and as the water reaches the final level there is noticed the "surge" usual with lock chambers of this size. This means that the columns of flowing water continue to run a few seconds after the level in the chamber has reached that outside so that the chamber level still continues to rise slightly and in so doing starts open the lock gates. With lock gates operated by hand this feature is often of much assistance to the lock-tenders in commencing to open the gates.

When the chamber is filled and prior to starting the lower siphon, valve *A* must be closed and valve *B*, which admits the air to the upper siphon, must be opened, thus allowing the water in the neck to fall below the level of the crest. Unless this is done, any difference of level in the lock chamber caused by commencing to empty it would start the water in the neck of the siphon running again, and it would be impossible to empty the chamber without thus stopping the flow.

In order to empty the lock the same process is used as for filling it. In case the valve *B* at the lower siphon was not left open during the filling of the chamber, so that the air in the siphon could find an escape as the water rose, it must be opened for a few seconds and then be closed again before starting to empty the chamber, as otherwise there would be an excess of air inside, which would go far to neutralize the vacuum in the tank. The lower siphons are less rapid than the upper ones in starting, as the air has to travel to the tank through some 250 feet of pipe in each wall and around several bends. Moreover, the air which the water begins to carry out after the siphon has started to prime itself does not appear to escape as readily as at the upper end, as it has a less direct route to travel before it can get free. Tests showed that the operation takes from three-quarters to a minute longer, the first discharge of air appearing at the culvert outlet in from 1½ to 1¾ minutes. The vacuum gage, however, indicates that the flow of air from the siphon to the tank reverses in about 45 seconds. As the outflow increases, the amount of air carried in the water continues to increase, and the discharge for a minute or two is a compound of air-bubbles and water changing gradually until all the air has been discharged. The vacuum gage in a manner similar to that described for the upper siphon, commences to register a steadily increasing pull until, when the discharge is in full play, it sometimes reaches as high as 13 or 14 inches, or nearly double that at the commencement of the operation. After the flow has stopped, the needle gradually settles back to the original figure indicated. The emptying of the lock, using both siphons, takes 5½ to 6 minutes.

It will be seen from the foregoing description that once the tanks have been made ready for work the operating power is self-renewing, so that, were there no leakage of air into the tanks, lockages could be conducted at any time and by merely manipulating the 4-inch air valves. While tests for leakage have not yet been concluded, the experience obtained thus far seems to indicate that the tank will retain a sufficient vacuum for 2 or 3 hours after the last lockage. However, in order to avoid having to refill the tank when traffic is very infrequent, the plan has been adopted of closing the 20-inch outlet valve, thus holding the water in the tank. On opening the valve again the apparatus is at once ready for use.

The highest kite flight on record was made at the Mount Weather Observatory of the United States Weather Bureau May 5th, 1910, when altitude of 7,262 meters (23,826 feet) above sea level was attained. The highest previous flight was made at the same observatory October 3rd, 1907, when an altitude of 7,044 meters was reached. The altitude of the observatory is 526 meters (1,722 feet).

THE ENERGY OF COMPRESSED AIR

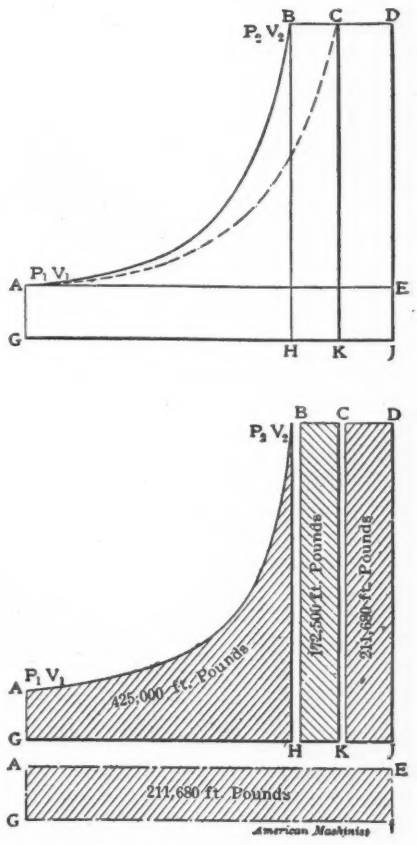
By Snowden B. Redfield.

Up to the present time, for many classes of work, no other medium of power transmission has successfully taken the place of compressed air. Its ultimate economy in dollars and cents is well recognized, but there still are many phases of its nature not universally understood which have led to the promotion of schemes for power development and transmission, with which, if the backers and those brought into the transaction were more conversant, they would have nothing to do, and so would be spared financial loss.

The most universal piece of practical knowledge on the subject of compressed air is the fact that it requires power to compress it, and that when once compressed it has the capacity of doing work in various machines designed for that purpose. It is also known, though not so widely, that the transformation of power into compressed air, and from compressed air back to power again, involves considerable loss. Another well known fact is that air while being compressed becomes greatly heated, and that while expanding in the working machine it grows intensely cold, as is often evidenced by the freezing of exhaust ports of pneumatic machines, much to the discomfort and annoyance of the operators.

What is probably not often realized by the practical man is the fact that the greatest losses in power economy of compressed air are due directly to these evidences of heat and cold. However, what would probably prove the crowning surprise to this practical man would be the statement that, of all the energy in the coal burned to drive the compressor, not one foot-pound of this energy reaches his air-operated machine through the compressed air, but that what really drives this machine is the expansion of the atmosphere itself and that the energy required to expand this atmosphere comes from the heat in the atmosphere.

The truth of the matter is that all the work done upon the air in compressing it is transformed into heat, and this heat is usually entirely dissipated into the water jackets and intercooler of the compressor and aftercooler if one is used, or in radiation from the pipe line, before reaching the driven machine. The compressed air reaching its destination at atmospheric temperature, no matter what its pressure, contains not one foot-pound more energy than it contained before compression.



COMPONENTS OF AN AIR-COMPRESSOR INDICATOR DIAGRAM

These are very radical statements and those who are interested will insist upon convincing proof before accepting them as truths. The proof of these statements must necessarily involve theory and methematics, but in order to overcome the well known popular aversion to formulas, the arithmetical results of each step will simply be stated.

CONDITION OF THE PROBLEM.

The diagrams shown will be recognized as an adiabatic single-stage indicator diagram of an air compressor, the lower one being separated into its component parts. The area *A B D E* represents the net work done in the compressing cylinder. The line *A E* represents the absolute pressure of the atmosphere or 14.7 pounds per square inch, and the line *B D* rep-

resents the discharge pressure, which, to illustrate a practical case, is made 114.7 pounds per square inch absolute, or 100 pounds gage. To avoid decimals, the volume represented by the length *A E* may be taken to represent a cylinder volume of 100 cubic feet, and it will be assumed that the piston makes one stroke per minute, thus compressing 100 cubic feet of free air from atmosphere to 100 pounds gage pressure in one minute.

WORK DONE IN COMPRESSING THE AIR.

The principles of thermodynamics, as illustrated by the familiar indicator diagram, teach us that the work done in compressing a gas from one pressure and volume to another, by any law that may be represented by a line, as for instance the adiabatic curve *A B*, is equal to the entire area under that line, down to the absolute zero line, this area, of course, being figured to the proper scale.

Bearing this in mind, we have that in moving the piston to compress the air in the cylinder under consideration, from pressure and volume P_1 V_1 to pressure and volume P_2 V_2, the work done on the air by the piston is represented by the entire area under the curve *A B, or* the diagram *A B H G*, taken to the proper scale.

In doing this work, the piston is supposed to have traveled from position *A G* to position *B H* and, of course, no back stroke in the other direction is supposed to have yet been taken. The total area of this part of the diagram figured, or measured, and taken to the proper scale, will be found to be 425,000 foot-pounds. This is the work done in compressing the air from volume *G J*, or 100 cubic feet, to volume *H J* and raising its pressure from atmosphere to 100 pounds gage. Starting with 100 cubic feet and atmospheric pressure, and compressing to 100 pounds by adiabatic compression, the volume of the air *H J* or V_2 will be 23.26 cubic feet.

EXPELLING THE AIR FROM THE CYLINDER.

Let the curve *A C* represent that of isothermal compression. The law of this compression is that the temperature remains constant throughout its entire range, and that the product of the absolute pressure and volume at any point is equal to their product at any other point. Under these circumstances, the volume of the air represented by the length *C D* will be 12.816 cubic feet. In advancing the piston to position *C K* from position *B H*, pushing the air out of the cylinder through the discharge valves at 100 pounds pressure, the work done by the piston is area *B C K H* and is the volume *H K*, multiplied by the pressure per square foot, or $(23.26-12.816)\times 114.7\times 144=172{,}500$ foot-pounds. Then the entire work done by the piston from the beginning of the stroke to position *C K* is 425,000+172,500=597,500 foot-pounds.

WORK DONE BY THE ATMOSPHERE.

The work required to push the rest of the air out of the cylinder into the receiver at 100 pounds gage pressure will be area *C D J K* and is, by a similar calculation, 211,680 foot-pounds, bringing the total work done by the piston up to 809,180 foot-pounds to compress 100 cubic feet of free air from atmosphere to 100 pounds pressure and force it out of the cylinder and into the receiver. Now all of this work did not come from the motive power driving the compressor, for while the piston has been moving forward, compressing the air, the atmosphere has been exerting a pressure on the back of the piston, of 14.7 pounds per square inch absolute, and helping the piston. The work done by the atmosphere and represented by area *A E J G* is then the product of the atmospheric pressure and the volume swept through, or 211,n80 foot-pounds; which it will be noted, is the same as the work done in area *C D J K*. This leaves the net work done by the motive power of the compressor, 809,180, less 211,680 or 597,500 foot-pounds and this amount of work has actually come out of the coal pile.

THE PART PLAYED BY HEAT.

Now that this amount of work is proved to have been done by the compressor let us see what has become of it. At the point *B*, the air is very hot, due to the compression. Its temperature may be calculated by the adiabatic formula and assuming 60 degrees Fahrenheit initial temperature, we will find 484 degree Fahrenheit at point *B*. After the air has passed out of the cylinder and again cooled down to atmospheric temperature, in the pipe line, its volume will have shrunk to the length *C D*, which has already been shown to be 12.816 cubic feet. In thus cooling and shrinking, the air has given out an amount of heat equal to the weight of the air multiplied by its specific heat, and by the difference in temperature. The weight of the 100 cubic feet of free air originally in the cylinder at 60 degrees Fahrenheit

is 7.63 pounds and this weight will not have changed, no matter what the pressure and volume, so the heat lost from the air during the process of cooling, after compression, and before reaching the driven machine is $7.63 \times 0.2375\ (484-60)=768$ British thermal units.

In this expression, the figure 0.2375 is the specific heat of air at constant pressure.

A British thermal unit is equivalent to 778 foot-pounds of work, so the amount of work lost by the radiation of the heat of the air is 768×778 or 597,500 foot-pounds.

A glance back will recall that the amount of work actually coming from the coal pile to drive the compressor in compressing and expelling 100 cubic feet of free air, at 100 pounds pressure was actually 597,500 foot-pounds. What could be more convincing than this, that all the work done by the compressing engine has been dissipated in radiation of heat from the compressed air, on the way to the air-driven machine? One thing will perhaps be more convincing. It is this: In compressing 100 cubic feet of free air to 100 pounds pressure in one minute, by single-stage adiabatic compression, the indicated horsepower in the compressing cylinder will be, by the well known formula:

I.h.p.$=1.511\ P_1\ (R\quad -1)$ where P_1 is the absolute initial pressure in pounds per square inch and R is the ratio of compression. This gives 18.106 indicated horsepower per 100 cubic feet per minute. Expressed in foot-pounds, thus:

$$18.106 \times 33{,}000 = 597{,}500 \text{ or } \frac{597{,}500}{778}$$

$=768$ British thermal units. Thus all signs point to the fact that the work done by the coal pile has disappeared into heat.

It should be further noted that the initial temperature of the air entering the compressor cylinder will not affect the power. A higher initial temperature will result in a higher final temperature, but being warmer, there is a less weight of air admitted to the cylinder per stroke and *vice versa*.

THE REAL SOURCE OF THE POWER

So far so good, but if all the work has been lost in heat, what drives the pneumatic hammers, drills and so forth? Looking back again at the indicator diagram and remembering that the air after being compressed and cooled, has a volume represented by the length *C D* or, as has been shown, 12.816 cubic feet, it will be realized that this is the volume of air entering the pneumatic machine driven, and this is the piston displacement of this machine per minute or during the time that the compressor was compressing and discharging the 100 cubic feet of atmospheric air just considered. As this air is admitted to the driven cylinder at 100 pounds pressure, or 114.7 pounds absolute, the work done on the face of its piston during this time will be the product of the displacement and the pressure acting, or $12.816 \times 114.7 \times 144$ or 211,680 foot-pounds, which is exactly the same as the area *C D J K*, which is also the same as area *A E J G*, which latter, it has been shown, was the work done on the back of the piston of the compressor by the atmosphere.

This now proves that all the work done in the air-driven tool has come from the expansion of the atmosphere, acting on the compressor piston, which is the assertion, the truth of which we have been endeavoring to establish.

EFFICIENCIES.

Beyond this is the fact that the whole of this work does not actually reach the tool, and this aside from mechanical friction, which has not been considered at all in this discussion. The further loss of work is due to the fact that on the other side of the driven piston the atmosphere is exerting a pressure of 14.7 pounds absolute, tending to retard it. This work of retardation again amounts to the product of the displacement and the atmospheric pressure, or 27,129 foot-pounds, and this deducted from the work done by the entering air, leaves a net amount of work which, neglecting mechanical friction, actually reaches the tool, of 184,551 foot-pounds.

This is the amount of useful energy obtained from an expenditure of 597,500 foot-pounds of work given up by the compressing engine, or an efficiency of

$$\frac{184{,}551}{597{,}500} \times 100 = 30.9 \text{ per cent.}$$

This is the theoretical "thermal efficiency" of an air compressor and a pneumatic tool, rock drill, or similar device using air nonexpansively at 100 pounds pressure, compressed in a single stage, and does not include pressure drop, leakage or friction losses. These mechanical losses would reduce the practical efficiency to about

half of the theoretical value, making the actual efficiency probably about 15 per cent.

If the compression had been compound, to 100 pounds pressure, the theoretical thermal efficiency of the compressor and tool would be 36.4 per cent. and the actual efficiency probably about 18 per cent. This thermal efficiency depends upon the air pressure used, and decreases as the pressure increases. Also the lower the pressure, the higher the efficiency, but in order to do a given amount of work with a low pressure, it would be necessary to increase the size of the driven cylinder, and it has been found that the most commercial sizes, combined with power economy, leakage, etc., demand a pressure between 80 and 100 pounds.

Objection may be made that this discussion is based upon the adiabatic compression curve and so is not practical. The fact is that while the actual compression curve is slightly below the adiabatic, this means that some of the work of the air compressor goes directly into the water jackets as heat, instead of being lost in radiation from the pipe line later. The argument would be the same under these practical conditions, with the actual temperatures and pressures, for the practical compression curve can be mathematically expressed just as well as the adiabatic, but the explanation and argument would be much more complicated and would lead to the same result.

If compressed air is so wasteful of power, why is it becoming more and more widely used? The answer to this question is that the vast saving in labor cost as opposed to other methods of working, so far overbalances the comparatively low power economy that the latter feature is secondary, and also many things can be done with compressed air that can be done with nothing else.

The power economy of compressed air may be increased by various means: Compounding, expansion and reheating, all of which subjects have been discussed in previous articles. —*American Machinist.*

Vanadium cast iron was specified for the cylinders of 183 new locomotives recently built for the N. Y. C. and H. R. R. A pair of cylinders of this material in service two years, on an engine which ran 200,000 miles, showed only microscopical wear.

LARGE FUEL OIL VAPORIZER

The sketch herewith represents in detail a high-pressure oil vaporizer or burner that has given good results in one of the largest forge shops in the middle West. It was designed by the superintendent and brought to its present efficiency after several month's of experimenting. Several different types of high and low-pressure burners were secured from prominent houses and fitted to the furnaces under the eye of the demonstrators that came to superintend the installations. We had all the facilities necessary to try each burner under conditions prescribed for it, namely, fan blast, 6 ounces; compressed air, 100 pounds; oil pressure, 40 pounds; and the use of reducing valves, pressure gages, a standard oil meter and the old reliable stand pipe or tank that could be filled with oil and the amount of oil used by each burner could be determined to an ounce.

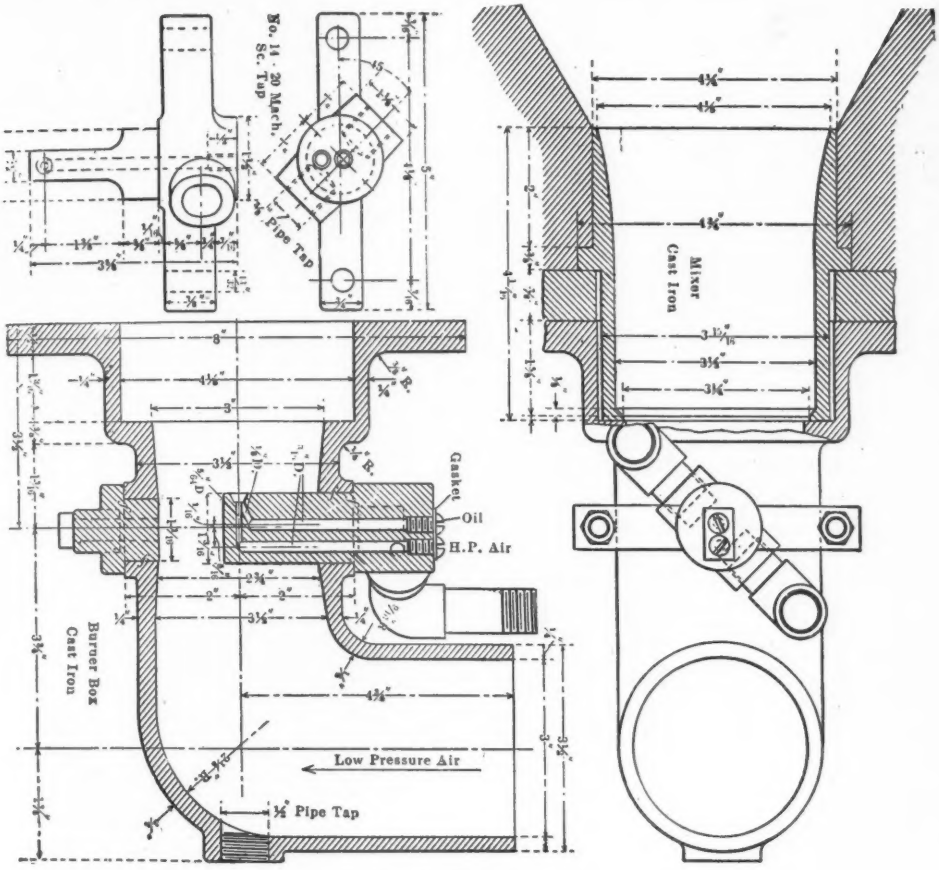
The burner had to heat a furnace 3½x5 feet and 14 inches high. No rules were laid down as to how the furnace should be built, and it could be fired from the front, back or side.

The cost of building the furnace; amount of oil consumed per hour; time required to bring furnace up to the required heat after lighting; control of the fire; and the time steel could be exposed to the flames with the mimimum amount of scale, were the points that would decide for or against the burner.

With the low-pressure burners we found that the time required to light the furnace and raise it to the proper heat was one hour and fifteen minutes; the amount of oil consumed was nine gallons per hour. The oil not being properly broken up or vaporized, made it difficult to light and the furnace smoked so badly while heating up that we discarded this kind of burner early in the game. We then turned our attention to the high-pressure burners, which had their good points and burned about the same amount of oil.

They all required so much fan blast and compressed air that the amount of scale that formed on the steel gave us no end of trouble.

We then found that by reducing the compressed air to seven pounds and the oil to thirty, with just enough fan blast to keep a circulation in the furnaces, we could get ideal results with the vaporizer shown. Some of the others failed to work successfully on this amount of air and others that did, were dis-



LARGE OIL VAPARIZER.

carded because the valve was difficult to clean when it stopped up.

With the burners shown, it is not necessary to strain the oil and the heavy grades will work satisfactorily. The mixer casting is cemented to the furnace. As the burner box bolts against the same, a tight joint can be made with a small amount of asbestos cement and prevent the oil from running down outside.

The blast gate is fitted to the top of the burner box to control the blast and the oil and compressed-air pipes are fitted with needle valves. The mixer nozzle channels can be cleaned without disconnecting the piping by removing small screws on the top and inserting a wire, a feature that is very desirable. The hole in the back of the burner box enables the operator to see the effect of the blast on the fire and see the end of the mixer nozzle while cleaning the same. We have had good success with this burner for the last two years and have placed it in the hands of others to try. All speak in the highest terms of its efficiency.—*Forgeman, Cleveland, in American Machinist.*

USE AND CARE OF PNEUMATIC TOOLS

[The following comprises the essential portions of an address by Mr. J. H. Simons, of the Chicago office of the Ingersoll-Rand Company, before the Railway Tool Foremen's Association.]

It is doubtful if any piece of machinery pays a greater profit on its investment or cost than a pneumatic hammer or a pneumatic drill kept in good working condition, yet it is equally doubtful if there is any piece of high-speed machinery so much abused by neglect to properly

clean, oil and renew worn parts, which condition retards the full admission of air to all the parts, interfering with the free movement, and rapidly cuts down the efficiency and capacity of the tools. Pneumatic tools, like all other high class machinery, must receive proper care and lubrication to give the best results. One of the most important factors connected with their proper care is to keep them clean and well lubricated. All pneumatic tool companies should proportion and construct their pneumatic tools in such a way that none of the parts will break from actual service unless some part is defective and escapes the different inspectors' notice at the factory, which is liable to happen once in a great while in the most up-to-date and best regulated plant in the world, but if a wood boring drill, or a metal drill, is improperly applied; that is, used on other work than for which it was designed and built, or overloaded by forcing it beyond its rated capacity, something may happen. For instance, if a drill is constructed to drill 1¼ in. holes and is used for drilling 2 in. or 2½ in. holes, then that something may happen.

It is reasonable, to expect, and it is a fact, that in pneumatic tools, as in all other high-speed machines, the rapidly moving parts will wear in time—the pistons, ball races, balls, throttle valves, etc., in pneumatic drills, and the throttle levers, bushings, valves, pistons and cylinders on pneumatic hammers, and when the wear is sufficient to prevent the full and free admission of air, or the escape of air by leakage past a worn part, it reduces the efficiency of the tools, and the part, or parts, should be removed. If this is done the machines will maintain their efficiency indefinitely.

The greatest abuse, therefore, to which pneumatic tools can be subjected is the failure to properly clean and lubricate them. An almost universal feeling seems to predominate on the part of operators that a pneumatic tool should run and develop its full power so long as all the parts are held together, without any regard to cleaning, oiling or tightening up. The cleaning and oiling of pneumatic tools should not be delayed until they stop working on account of dirt, rust or gummed oil. They should be thoroughly cleaned with kerosene or benzine once every twenty-four hours, as the air taken into the compressor generally contains some grit or dust. It is almost impossible to prevent this foreign matter entering the working parts of the tool, thus causing the parts to become clogged and rendering the tool inoperative. A good plan in such cases is to thoroughly clean by pouring benzine or kerosene freely into the throttle handle. This dislodges all foreign matter and cuts the thick oil, which can be removed by blowing the air under pressure through the tool, then lubricate in like manner with a good quality of light body oil. Sewing machine oil or a winter strained lard oil is very good. Heavy oils should never be used on pneumatic hammers or piston drills, as they cause the tool to work very sluggishly, with consequent loss of power. However, heavier oils should be used on the rotary type of drills.

When pneumatic tools are not in use it is a very good plan to keep them immersed in kerosene. They should be suspended so that the dirt and foreign matter will settle to the bottom of the vessel and then be thoroughly blown out and well lubricated before being put into operation, as kerosene leaves them dry. It will well repay any user of pneumatic tools to keep the inside of pneumatic tools as clean and well-oiled as a sportsman would his gun. We advocate, especially where the air is usually laden with foreign matter, the use of strainers on the tool and filters in the pipe line, arranged so that they can be readily taken apart and cleaned. A good form of pipe line filter is two cast flanged pieces properly tapped and threaded to fit the pipe line, bolted together, with a piece of gauze or fine mesh wire screen between. This can be made in any railroad shop. There are also sundry makes of automatic oilers for pneumatic tools, which are placed in the hose line a short distance from the tool, and which can be refilled at any time without disconnecting the tool from the hose line. They are made in sizes to supply oil for from six to eight hours without refilling.

Another abuse, especially with regard to pneumatic riveting hammers, is a rapidly increasing tendency on the part of operators, particularly where the hammers are used in construction of steel cars and in structural steel shops, more especially where "hunky" labor is employed, to use pistons shorter than those adopted by the makers as standard. This is the most flagrant abuse to which a riveting hammer can be subjected, and I cannot too strongly condemn this practice. The riveting hammers are designed with parts properly proportioned to meet the requirements of the

various classes of work to which these tools are adapted. Workmen have discovered that a shorter piston than the one furnished with the hammer increases the number of blows per minute and for a time facilitates their work. They usually make these pistons by grinding down a broken standard piston, thus removing the hardening in a large degree, and leaving the striking part softer than it should be. These short pistons have a tendency to crumble, and the broken parts cut the inner casing of the cylinder, and if it is not damaged beyond repair from this cause it is only a question of a short time when the cylinder will crack or the handle will be broken. When cracked cylinders, broken handles and broken rivet sets are experienced the hammer should be carefully examined to ascertain whether or not the workman has substituted a short piston and this can only be done when the hammer is in service, as it has been found that the workmen carry the short pistons with them and make the exchange after taking the hammer out of the tool room, replacing the proper piston when returning the hammer at the close of the day. In some of the large manufacturing plants hammers have been discovered working with a short stub of a piston not more than two inches in length, ground conical on the striking end, and the managers of these plants have issued instructions making it an offense punishable by discharge where such conditions are found. One of our largest industrial organizations, operating some eight or ten plants, inaugurated about a year ago a system for keeping a thorough inspection and record of pneumatic tools from the day of purchase until they had become obsolete or worn out. A record is kept of every item of repair made to a tool and a report is filed showing why the repairs are made necessary, that is, whether from abuse, lack of care, bad hose, natural wear and tear, or accident. The mechanical engineer in charge recently informed me that in looking over the report for the first six months he was greatly surprised to find that about 30 per cent. of the causes of repairs could be directly attributed to neglect in cleaning and oiling and about 15 per cent. to the use of inferior hose.

IMPORTANCE OF AIR PRESSURE.

Another important factor to be considered in the getting of the very best results out of pneumatic tools is the air pressure. We have found after a very careful and paintaking investigation that, so far as the air pressure is concerned, one should have between 90 and 100 pounds of air to get the best results. The Canadian Government will not accept steam tight rivets driven with pneumatic hammers unless these hammers are operated by 110 pounds air pressure. All pneumatic tools can be operated on less pressure, but you will find, as I say, that 90 to 100 pounds of pressure will give the best results.

In conclusion allow me to offer a few suggestions applying to all makes of pneumatic tools, which, if followed, will insure you more and better work from your equipment and will obviate delays and annoyances and minimize the expense of maintenance.

First, see that the tools are well cleaned and boiled before putting them in operation.

See that the pipe lines are thoroughly blown out before connecting the tool.

Use the best quality of air hose. It is cheaper and more satisfactory in the long run.

See that your pipe lines are provided with filters or that strainers are used with the tools, preferably both.

With drills, adjust the ball-bearings, where they are provided, so as to take up the lost motion, and be sure that they are firmly held by the lock nuts to prevent working loose or tightening up and binding when in use.

With your pneumatic hammers be sure that the handle is always on tight, as the tools may be seriously injured by allowing this to work loose. This controls the joint between the handle in valve box and is of great importance.

See that the operators hold their riveting and chipping hammers firmly against the work. If the die or chisel is allowed to play in and out of the hammer while in operation it will seriously damage the tool. Every blow should be delivered on the die or chisel and not on the forward end of the bridge of the cylinder in chipping hammers. With riveting hammers, which have no bridge in the cylinder, it often means the loss of the die and piston by being shot out of the tool. Besides, in structural work it makes it dangerous to pedestrians in streets and thoroughfares below. There is no way of protecting against injuries of this nature except by care on the part of the operator.

See that the chisel and rivet sets fit properly in the nozzles and are of proper length, otherwise there is an opportunity for loss of power and injury to the tool.

IMPROVED OXY-ACETYLENE APPARATUS

The accompanying cuts show the essential features of an improved form of welding or metal cutting apparatus put out by J. M. Jackson & Company, Limited, of London, Manchester and Glasgow.

The casing of the generator is constructed of steel plate, welded at the joints by the process it is designed to work. It is fed with coarse-grained carbide, which while being cheaper, produces a greater volume of gas from a given weight than the fine-grained quality. A special feature is the ample size of the water tank, which effectually seals the apparatus and prevents the possibility of any escape of gas, while, as the whole of the gas has to pass up through this volume of water, it leaves the generator remarkably pure; although a scrubber is provided, this is more in the nature of a safeguard, as in practice it

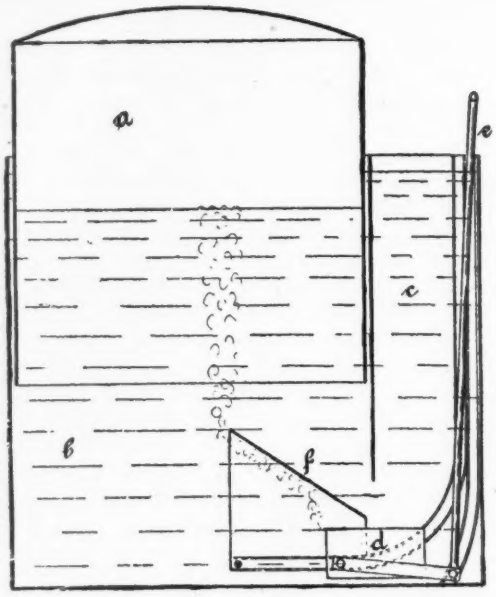


FIG. 2.

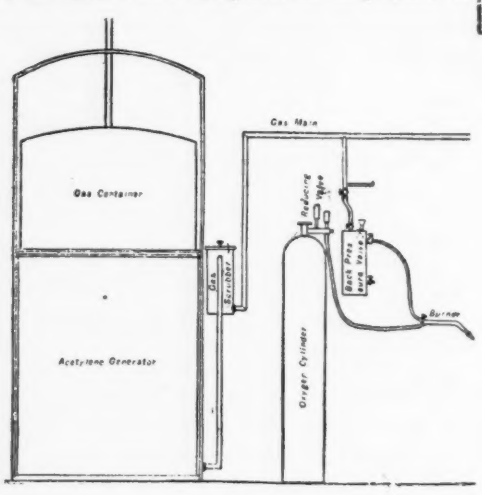


FIG. 1.

is not really necessary. The dimensions of the generator entirely eliminate heating troubles.

An important feature of this type of apparatus, which differentiates it from other makes should be noted. In this system the acetylene gas is generated in the water itself, and in consequence all the gas is got out of the carbide and the gas generated is purer and cooler; while, having to pass up through a large volume of water, the gas is entirely freed from sulphuretted and phosphoretted hydrogen.

Fig. 2 shows the generator in section. The carbide is placed in a box having a perforated bottom which is placed the reverse way in a second box and again reversed into a third box *d*, which is attached by means of a swivel joint to the lower end of the feeding lever *e*. The box is then lowered by means of this lever, through guides fitted at the sides of the water-filled shaft *c*. These guides are given a curve at the bottom which, acting on the swivel joint, causes the box containing the charge to be delivered under the hood *f*. It will be readily seen that, owing to the construction of the box, the water cannot come into contact with the carbide until the box is in position, so that there is no escape up the shaft. From the gasometer the gas passes through the scrubber and thence to the valves. A hydraulic back pressure valve, which prevents backfiring, is fitted close to the operator and the equipment includes a reducing and controlling valve for attachment to the oxy-

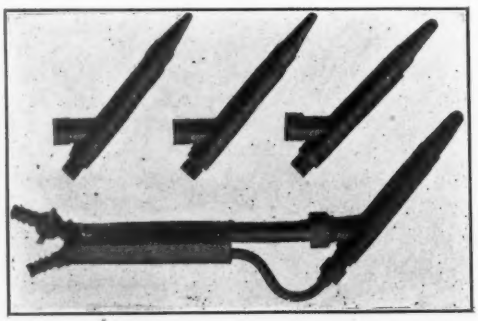


FIG. 3.

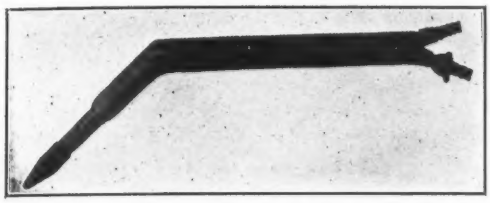


FIG. 4.

gen cylinder. The burners, which have been designed to economise gas and also insure perfect combustion, are made in two types. Where the work to be performed varies over a wide range of sizes, the burner consists of a mixing chamber with interchangeable burners, adapted to meet the particular requirement, see Fig. 3; where however, the work to be done is practically standard, the burner as in Fig. 4 is supplied.

EXTINGUISHING AN OIL WELL FIRE

On June 18 the Producers' Oil Co. drilled in its No. 6 well in the Hart's Ferry district of the Caddo field, in Louisiana. Several wells in the neighborhood had proved such vigorous gushers as to be hard to manage. Every precaution was taken to control this one by a 16-inch valve supposed to stand 800 pounds pressure.

The well began flowing at a greater rate than any well ever before drilled in the Caddo field, and has been variously estimated at from 8000 to 25,000 barrels a day. The effort was at once made to close it in pending the erection of suitable tankage, but a leaking nipple developed, so that, with the best they could do, some 3000 barrels of oil a day sprayed from the leading valves.

A "housing" was ordered from Shreveport with the hope of enclosing the valve, nipple and all, within a pair of castings which, when drawn together with bolts, would exactly fit around the entire valve and close the leak. On Sunday afternoon, June 19, while the castings were on the way to the field, a severe thunderstorm came up and caused great fear that the well might be ignited by lightning, an especially serious matter, as the well men working under this continuous shower of 3000 barrels of oil spray were constantly drenched with oil, which by the way, is about 43 degrees B. gravity, which means an oil with some 20 per cent. of gasoline and very inflammable. The general manager of the Producers' Company, Mr. James Sharp, who was personally in charge of the work ordered all the "greasy men" to run at once to the bank of Jeems Bayou, 100 feet away, and to plunge in if the storm came uncomfortably close. This was less than 10 minutes before the lightning struck and ignited the well, at 5 o'clock Sunday evening.

The situation now became a fight to extinguish this fire. The blaze of light oil was sprayed to an unusual height by the great volume of natural gas, and, with the gusty wind blowing the column of flame near to the ground in various directions, the danger to life and property was great.

The most practical scheme for extingushing the fire seemed to be to drown the flame by steam. This involved shipping 25 steam boilers from Shreveport by rail to Mooring's port. There they were unloaded and hauled about 300 yards to the bank of Ferry Lake. There is no wharf at the lake, and it was a tedious matter to reload the boilers onto barges, and it was no easy matter to tow these barges by way of the shallow lake and Jeems Bayou through the labyrinth of cypress trees and stumps to the nearest point to the well. There began the tedious work of getting the boilers up a muddy, slippery slope, and then of installing them. They were brought just as near to the fire as to avoid the licking flame should the wind drive it that way. Next a gang of expert pipefitters connected each boiler with a supply of natural gas from nearby wells. This alone would have taken a week in ordinary times, or say two months by day labor methods. Meanwhile another gang connected these boilers with steam pipes which were run still closer to the enemy to deliver the steam on the flame at short range. Word was sent to Shreveport that the flame would be extinguished at 6 o'clock Tuesday afternoon. As a matter of fact, it was put out one hour earlier. All the various features of assembling these boilers and getting up steam had been accomplished in just 48 hours of continuous work.—*Manufacturer's Record.*

GREAT GAS FIRE EXTINGUISHED BY STEAM

One of the greatest and at the same time the most spectacular of gas well fires in the history of the petroleum industry in California was recently conquered through the use of steam. The Standard Oil Company when boring for oil in the Midway field near the town of Taft opened up an immense reservoir of

gas, the flow being under such terrific pressure that it wrecked the derrick. The combustible immediately took fire from the boiler, consuming the wreckage and driving the workmen in all directions from the scene. The enormous pressure, said by some to exceed 1000 pounds to the square inch, caused the gas to leave the well with such force that it was prevented from burning lower than a score of feet from the ground. At that distance it spread out and burst into a violet flame, about twenty feet higher changing to a golden yellow. This huge torch twisted and roared for seven days before a way was devised to extinguish it, and terminate the tremendous waste. This was finally accomplished by the use of steam from six forty horsepower boilers. Four lines of steam pipe were laid from as many sides of the mammoth jet. Saftey valves were tied down, and when the pressure which the boilers were capable of withstanding was reached, the steam was projected on the flow of gas. The mixture of the steam with the gas caused the oxygen to be shut out, and the great flame sputtered, dwindled and finally died out. The well was then capped and brought under control and arrangements are now being made to pipe it to surrounding fields.

CONTRASTS IN MODES AND RATES OF COMBUSTION

By Charles Vickers.

The combination of oxygen with any substance, such as wood, coal or paper, produces a visible effect known as burning, the progress of which is attended with the total destruction of the substance burned and the evolution of light and heat. These visible effects have become so associated with "burning" that it often is difficult to conceive of anything being burned and not producing these effects. When, however, metals, such as iron or copper, combine with oxygen such results are not seen, but the process is that of burning just the same.

When iron rusts at ordinary temperatures there are no visible light or heat effects, although a combination of iron and oxygen has taken place. Heat, however, really is given off, but it is carried away by the air, as quickly as it is formed, and cannot be perceived. This combination of iron and oxygen is really slow combustion, the iron being burned, and in the course of time nothing is left but the ashes, familiarly known as rust, and, as might be expected from the ease with which it is formed, iron ash or rust, is very widely diffused in nature, and is found in most minerals, the ashes of many plants, and the blood of animals. The red, brown or yellow color of many kinds of molding sands is due to the iron oxides which they contain.

Copper and its alloys do not combine with oxygen as readily as iron, and at ordinary temperatures are very enduring. For this reason bronze is used for statues and in exposed positions on the better class of buildings. When copper is brought to a red heat, however, it combines with oxygen and forms copper oxide or rust. Thus, in burning off the insulation from copper wire, a scale is formed which is brittle and is easily detached in the shape of fine flakes or powder. This is copper oxide, and if the wire is again heated and allowed to cool, another layer of scale will be formed, and when the wire becomes very thin it will be found to be oxidized all through, and so brittle that it may be broken with ease. It will also be noted that the scales from the heated copper are of two colors, red and black. This is due to the amount of oxygen that has combined with the metal. The black scales contain the largest amount of oxygen, being composed of one atom each of copper and of oxygen, while the red contains two atoms of copper to one of oxygen, and is produced when the metal cannot get access to sufficient oxygen to form the black protoxide of copper. It will thus be seen that two layers of scale are formed when the metal is heated, the outside one being black, and containing the largest quantity of oxygen, and the inside one red. Both these layers are easily detached by pounding the copper, and before such copper is melted to make bronze, these scales should always be pounded off, because more scale will be formed during the melting process, making it extremely unwise to add any with the metal if it can be avoided.

It will be seen, therefore, that metals can burn, as well as those substances which in the burning give off light and heat. One important difference, however, should be noted, and that is that when wood is burned, the ashes which remain constitute but a very small portion of the original substance, because the greater part has been converted into gaseous bodies, by their combination with oxygen, and have escaped into the atmosphere. The metals, on the other hand, have lost nothing, but have gained

in weight, as they have taken oxygen from the air and formed a solid substance, the weight of which has been increased by the added weight of the oxygen with which it is combined.—*The Foundry.*

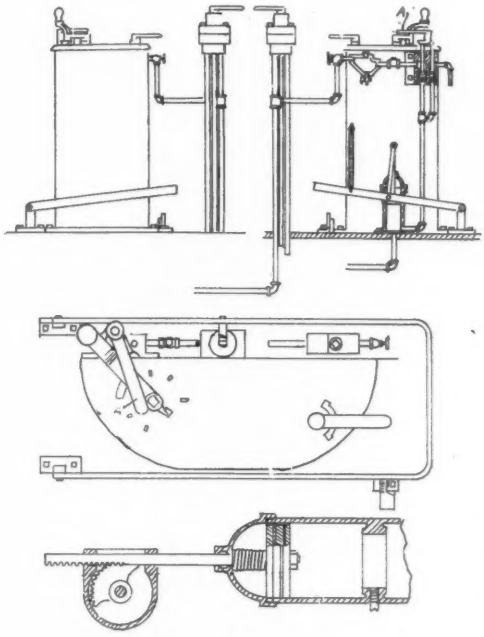


FIG. 1.

AIR OPERATED TROLLEY CAR GATE

There are now in use several different air operated devices for opening and closing the rear gates of trolley cars. The apparatus here shown was designed by Mr. Elmer E. Veley, master mechanic of the Cedar Rapids and Marion City Railway Company, the cuts being adapted from the pages of the Electric Traction Weekly.

The details of the mechanism are shown in Fig. 1. The gate can be operated by the motorman by the air attachments, or on cars without air by means of a foot lever. The air cylinder under the car has two pistons with rods extending out at each end and operating the gates by rack and quadrant. The controller handle and the gate operating handle are so arranged that the motorman cannot apply the power until the gates are closed. He can operate his controller on or off until the car comes to a dead stop when he can release the gates. They do not come together with a slam as they are equipped with a slow regulating device, so that should any one become caught between them no injury to person or clothing will result. In Fig. 3 a boy is caught between the gates and does not seem disturbed by it. The direct connection of the air pistons with the gate quadrants eliminates all lost motion.

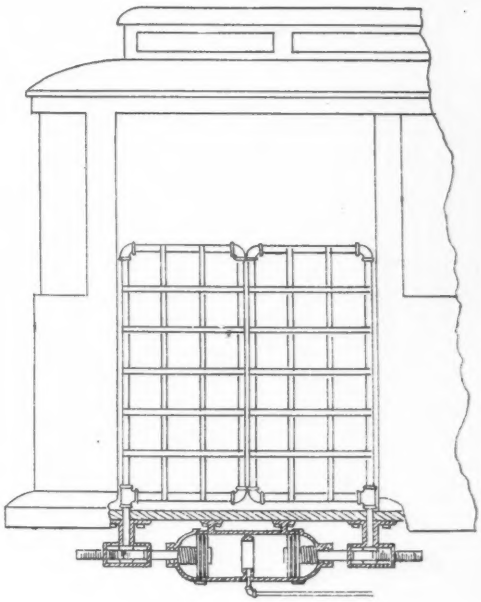


FIG. 2.

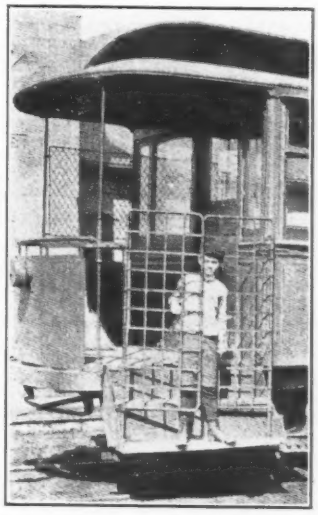


FIG. 3.

CONTROLLABLE DIFFERENTIAL AIR PRESSURE IN SURGERY*

By John B. Huber, A. M., M. D.

Until very recently, the surgeon ha· paid the thorax deep respect—that cage which imprisons the lungs, the pleura, the heart, and the great vessels; because, while the cerebrum and abdomen contain organs not immediately essential to existence, we should die almost instantly if the heart and the lungs (especially the latter) are put out of action, and because the resilient and elastic lung tissue tends to collapse, on opening the thoracic cavity, under the atmospheric pressure of fifteen pounds to the square inch, to which the surface of our bodies is subjected.

Before 1904, the thorax had indeed been entered, but not safely, unless inflammatory adhesions between the pulmonal and costal pleuræ protected the collapsible lung tissue against the ordinary atmospheric pressure. The surgeon must operate within the thorax as safely as anywhere else within the economy. So surgeons have recognized that such operations as thoracotomy and pneumectomy cannot be done with impunity without the aid of differential air pressure. Much experimentation has been done to this end, with the result that both the lungs and the esophagus may now be safely invaded. The heart may be exposed to view, the pericardium opened and the myocardium incised. All this is not the easiest thing in the world; nevertheless, the skilled surgeon may now proceed with confidence upon operations most hazardous a few year since.

In 1904 there were operating chambers in use in Europe. Brauer's apparatus is a single positive pressure chamber akin to that presently to be described. That of Sauerbruch is a negative pressure chamber, the patient's head being outside of it in the ordinary atmosphere, his body being in the chamber. They were made of metal; voices reverberated in them; surgeon and anesthetizer were separated by a solid wall; the noise made telephoning impossible; the operator could not see his patient's face, there was not sufficient room; there was no provision for breakdown of power; there was negative pressure only, or positive pressure only.

Up to the spring of 1908 the existing apparatus was of two types; one working from atmospheric pressure downward, negative pressure; the other from atmospheric pressure upward, positive pressure. There was none working both ways. Wherefore Dr. Willy Meyer of New York city, and his brother, Mr. Julius Meyer, an engineer, built a double chamber for use in positive and negative differential pressure. It was in this chamber that I saw the whole left lung of a dog removed.

There is an outer negative pressure chamber (the operating room) within which is a positive pressure chamber (the anesthetizer's room). It is thus possible to operate under either negative or positive differential pressure; under a combination of the two; or from one to the other in the same operation.

The advantages of combining two chambers to form one apparatus are: The operating table remains fixed under whatever pressure the operation is done; and there is avoided the moving of the table from inside to outside necessary with the European tables, should it be considered feasible to change the pressure from positive to negative, or *vice versa*. Moreover, in this Meyer chamber there is ample space for the surgeon and his assistants and nurses, arranged for by the projecting head box, in which there is an aperture closed by a rubber collar, adaptable to the size of the neck. The operator can see the patient's face, and the anesthetizer the body—not directly, however, but through a mirror; and attention is, therefore, not distracted from the work of anesthetizing. The anesthetizer and the head of the patient are in the smaller positive differential pressure chamber, which is of size ample for the use of oxygen and other apparatus, and has an airlock providing access and egress while the pressure is on, and without interruption thereof; from this chamber the ether fumes are ventilated off every minute.

The operating chamber needs no air lock. Its pressure can at any time be raised from negative to atmospheric pressure, while the differential pressure required for the operation is being maintained without interruption so that the door leading to the outside can then be opened. A triple reserve is provided in case of breakdown. There are two independently driven sets of pumps—one for pressure, and one for vacuum; so that in case of any mishap to one unit an immediate change

*Abstract from *Scientific American*.

can be made from one kind of differential to the other; in the event of accident to both units a hand pump is provided, for maintaining the positive differential pressure in the anesthetizing chamber. The motors run at constant speed. The variation of the air pressure in the chambers is effected by manipulations of two air valves, set by hand to the desired gage readings.

This structure belongs neither to the kind of apparatus that works from atmospheric pressure downward, nor to that working from atmospheric pressure upward. It is *sui generis*. The aim in its construction has been to overcome and remove the limitation of differential pressure chambers to atmospheric pressure as the fixed basis at one end of the difference in pressure; and to enable the establishing of the basis anywhere above or below, or at atmospheric pressure, at will. This was accomplished by combining two differential chambers in one apparatus, in which these modifications were possible: (1) The rooms may be separate; (2) they may have one corner in common; (3) or one wall in common.

To what pressure can the operator and his assistants expose themselves? Where is the danger line? Even should the negative chamber be exhausted to a differential pressure of 50 millimeters (1.968 inches) Hg., thus being strained to the limit of its capacity, they would still be within the limits of possible everyday experience; for in our climate barometric fluctuations of 50 millimeters Hg. are nothing unusual. The differential pressures used in thoracic surgery seldom exceed that corresponding to a difference in altitude of from 250 to 300 feet; that is, the patient's mouth is lowered about 300 feet below his opened thorax. However, surgeon, assistants, anesthetizer and nurses are not under differential pressure at all; their entire bodies are under only one pressure.

This combination of medical and engineering science was begun early in 1908. Numerous difficulties were met; on December 23rd 1909, the Universal Differential Pressure Chamber was tested: it was first used in the Rockefeller Institute on January 8th, 1909; on May 7th, 1909, it stood complete.

It may be *apropos* to consider briefly, other contrivances by which atmospheric changes are made for medical purposes. There is the Kuhn pulmonary suction mask, which at two hourly intervals is placed over the nostrils and mouths of sufferers from pulmonary tuberculosis asthma, anemia and certain heart affections, the purpose being to produce a rarefaction of the air in the chest, with a consequent hyperemia. Then there is the pneumatic cabinet, which Dr. C. E. Quimby and other physicians in this city have for at least a decade past been using for pulmonary and cardiac affections. On entering this cabinet one breathes the ordinary atmosphere from without through a rubber tube, while he is subjected to negative pressure. An odd sensation here is that in expiration one has actually to push out the air from one's lungs, and with some little effort. Another is a compressed air chamber, seemingly as large as a fair-sized living-room; there is at least one of these in London, though I do not know of any in New York city.

EXPLOSIVES IN TUNNELING

The selection of explosives for tunnel blasting probably requires a more careful study of conditions than for any other kind of excavating. Maximum speed in driving cannot be attained unless the explosive best adapted to the work is used. When starting a tunnel or drift, it is a good plan to thoroughly try out several explosives which are distinctly different in action, before finally adopting any one of them. The results, however, from this preliminary trial will be of little or no value, unless each different explosive is used under exactly the same conditions. Care must be taken to see that no change occurs in the character of the rock, number and direction of the bore holes, strength of the detonator, kind and quantity of tamping, amount of water encountered, method of connecting up the bore holes for firing, and that the explosive is always thoroughly thawed. If a material change in any of these conditions occurs as the work progresses, further tests should be made to determine whether a quicker or slower, a stronger or weaker, explosive might not break the ground or bottom the bore holes better, or make it possible to bring out the cut with fewer holes or deeper ones. The speed at which rock can be drilled does not indicate how it will break, and not infrequently that which can be easily drilled is very difficult to blast.—*Mining World.*

MACHINES IN COAL MINING

One mining machine with three attendants will generally do as much work as 20 men can accomplish by hand labor. This saving in time, labor and cost has made mining machines indispensable. Every coal-producing State in the Union will eventually enforce laws prohibiting shooting coal from the solid. A machine using a cutter chain traveling horizontally across the face of the coal has the largest capacity and consumes the least amount of power. This style of coal cutter is most commonly used in America and is generally driven by an electric motor. Where a mine has rolling bottom or where a band of sulphur occurs near the bottom of the seam, many chain-breast machines will not work satisfactorily. In such mines, coal-punching machines are most often employed. The puncher machine is also especially adaptable in coal where the cleats are not well defined, as it allows a condition of shooting which places the coal in such a shape that it is easily loaded. Coal always rolls better when shot after being undercut with a puncher. Whether to adopt the chain-breast or the puncher machine at any mine is a question that requires careful consideration.

SAVING BY USE OF MACHINES.

As to the saving that results from machine mining, it may be said that at a mine producing 1000 tons per day and having a 15c margin in favor of machine mining, the gross saving would be about $150 a day, or $30,000 per year of 200 days. In such a case the company can maintain its output with 20 per cent. fewer men than are required when hand mining is employed. The $30,000 saving will pay for the machine plant, installation and cost of maintenance, as well as interest and depreciation, in about one year's time.

The advantages of coal cutting are, (1) an increased percentage of large coal; (2) the coal is mined in a firmer and better condition; (3) a more regular line of face is obtained, leading to more systematic timbering; (4) increased safety conditions for the miner; (5) thin seams can be profitably mined; (6) increased output; and (7) fewer explosives are required for getting down the coal. The effectiveness of machine mining is shown by the fact that American coal operators, with fewer men, produce 60 per cent. more coal than is mined in Great Britain.—*Floyd W. Parsons in Engineer and Mining Journal.*

DIFFERENCES IN STEAM CONSUMPTION OF COMPRESSORS

Suppose that a compressor is required to compress 500 cu. ft. of free air a minute, delivering to a receiver at 100 lb. gage. A two-stage machine of that capacity will require approximately 92 i. h. p. to perform the work. Now, while the best straight line compressors are furnished with Meyer valves, they are usually set by the operator to cut off constantly at about three quarter stroke, and with such setting they will require on an average 45 lb. of steam per horse power hour, while Corliss duplex machines with cross compound steam cylinders will do the work with 15 lb. of steam or less. There is not only thus a saving of two-thirds of the coal consumption, but also a corresponding reduction of boiler plant, and the labor and other cost of its operation.

HYDRO-ELECTRIC POWER FORMULAS

Knowing the quantity of water and satic head in feet, four very simple rules for determining the hydro-electric output of a power-plant have have developed. Three units of water measurement are embodied and the output can, therefore, be calculated direct without conversion.

A miner's inch (m. i.) is taken as 1.5 cu. ft. of water per minute.

(a) 1 m. i. will develop 2 hp. with 1000-ft. head.
(b) 1 min. ft. will develop 1 kw. with 1000-ft. head.
(c) 1 sec. ft. will develop 8 hp. with 100-ft. head.
(d) 1 sec. ft. will develop 6 kw. with 100-ft. head.

(a) Q (miner's inch) $\times$ H (feet) $\times$ 0.002 = hp.
(b) Q (cu. ft. per min.) $\times$ H (feet) $\times$ 0.001 = kw.
(c) Q (cu. ft. per sec.) $\times$ H (feet) $\times$ 0.08 = hp.
(d) Q (cu. ft. per sec.) $\times$ H (feet) $\times$ 0.06 = kw.

The conversion of kilowatt to horse-power or *vice versa*, can readily be made in the usual manner. The value of these equations lies in the fact that losses such as friction or head loss in the pipe, generator, water-wheel, and transformer losses are all taken into consideration, that is, at the values usual in high-head installations of Western practice.

Assuming a pipe-line efficiency of 95 per cent., a waterwheel efficiency of 80 per cent., a generator efficiency of 96 per cent., and a transformer efficiency of 98 per cent., the plant efficiency is 71.5 per cent. Allowing a still further loss of 1.5 to 2 per cent. for inefficiency in regulating nozzle losses, etc., the switch-

board output will be 70 per cent. Assuming well known constants, the following deduction from one of the formulæ may be given:

w=62.5 lb. weight of 1 cu. ft. water.

1 hp.=33,000 ft. lb. per min.

1 m. i.=1.5 cu. ft. of water per min.

Q=quantity of water.

H=static head from forebay to centre of nozzle for impulse wheels and from surface of head-water to tail-water surface in the case of turbines.

From the well known equation $P = QwH$ may be calculated P or $\text{hp.} = \frac{1.5 \times 62.5 \times 1000 \text{ ft.}}{33{,}000} \times 0.70 = 1.990$, or practically two horse-power, the approximation being large by one-half of 1 per cent. The other formulae are obtained directly or deduced from the foregoing.

Say that at a certain power house there is continuously delivered 3,500 m. i. of water with a head of 830 ft. Then:

$3{,}500 \times 830 \times 0.002 = 5{,}810$ h. p. or 4,360 kw.

IMPROVED DRAEGER RESCUE APPARATUS

Over 3,600 sets of the Draeger rescue apparatus are now in use in different parts of the world. The experience accumulated has suggested many improvements which have been adopted from time to time, and the inventor has been continually engaged in dealing with practical difficulties the successful solution of which has at last enabled the firm to introduce a new apparatus, which, while retaining all the best features of the old type, embodies many improvements, one of which at least is of a most important character.

In the older apparatus, the length of time a man could work in a noxious atmosphere was limited to two hours, which could possibly be extended to three, by an experienced man husbanding his resources. It frequently happened therefore, that by the time a rescuer had reached the scene of the accident, he was compelled to return, owing to the limited supply of his oxygen. The problem was to construct a smoke helmet with a longer "life" without increasing the weight. Messrs. Draeger have not only accomplished this, but have actually succeeded in reducing the weight. With the new apparatus, it is possible for a man to remain in gas for a length of time only limited by his physical endurance. There are already, we

REPLACING OXYGEN CYLINDER.

are informed, records of men working continuously in poisonous gases for over seven hours.

In principle, the machine remains exactly the same. An oxygen cylinder and a potash cartridge is fitted to the frame, which will enable the wearer to breathe in comfort for two hours; instead, however, of having to return to the base to obtain fresh charges, these can be fitted instantaneously with perfect safety in the most poisonous atmosphere. The half tone shows the exchange of oxygen cylinders in smoke in thirty seconds (the breathing will not be affected even if the changing occupies several minutes). No smoke or gas can get through the small capillary tubes of the oxygen-reducing valve. The exchanging of the potash cartridge only occupies four seconds. During the time of the exchange, self-acting valves are shutting off the openings in the apparatus and preventing the entrance of noxious gases. Thus it will be seen that by a system of relays bringing up supplies of reserves, teams can work continuously until their object has been accomplished.

Progress has been made not only in efficiency, but also in comfort. The black frame fits the body and the weight is distributed, so that it may be worn without effort. The new helmet is composed largely of soft leather, with a metallic window portion, and the pneumatic lining is of such a shape as to fit any head—long, short, broad or narrow—without undue pressure. The pneumatic rubber lining

in this helmet is stronger and safer, and the whole helmet is lighter in weight. The oxygen gauge is carried on the chest, so that the oxygen supply can be watched during work. An important feature of this apparatus is the reduced price of the cartridges.

IMPROVED GAS FOR BALLOONS

A process has been devised in Germany for improving the gas commonly used for balloons. Illuminating gas is forced through long tubes maintained at a high temperature. Most of the carbon is thus separated out and the percentage of hydrogen is largely increased, so that it then constitutes 80 per cent. of the whole. The specific gravity is reduced from 0.44 to 0.225, or less than one-quarter that of air. In coal gas 1 cubic meter (1.3 cubic yards) sustains 0.7 kilo (1.5 pounds). A cubic meter of the new gas sustains 1 kilo (2.2 pounds).

A TROLLEY ROAD WEED BURNER

A home-built weed burner successfully employed by the Northern Texas Traction Company is described in a recent issue of the Electric Traction Weekly. The outfit is mounted on a flat car and it sprays burning crude oil. There are four drums each 20 ft. long and 20 in. in diameter, the upper drum an air reservoir, and the three lower containing crude oil. Air pressure is supplied by a chain driven motor-operated compressor of 105 ft. capacity. A pressure of 150 lbs. is maintained in the air reservoir and a pressure of 80 lbs. goes to the oil drums. The compressor is water jacketed and a water tank is carried over the compressor. There are four burners inside of a drum extending across the track and carried about 3 ins. from it. The drum has a slot at its base and the burners project to the mouth of the slot. Lines from the air drum and from each of the oil drums connect just above each burner and valves are provided in each line to regulate the supply and pressure. By having the burners just inside of the drum the flame is given a whirling effect and spreads it the entire width of the track. Considerable difficulty was experienced in holding the flame down onto the track, and in preventing it from blowing back and setting fire to the car, so that a series of aprons had to be rigged up. The largest of these extends back 6 ft. and is 8 ft. wide, while other aprons protect the car framing and the tanks. The aprons are supported on a pair of T-rails extending the whole length of the car and back to the end of the largest apron. The outfit is trailed by a work car at the rate of 1½ m. p. h. and the work is done at night, 11 p. m. to 4 a. m. During summer months, the line is gone over every two weeks. The cost of operating the rig, including oil, train crew and power, is figured at $125 per month, and as it formerly cost $1,000 per month to dig and cut weeds, besides disturbing the track, the scheme of burning the weeds is looked upon as a very satisfactory investment.

OVERHEATING OF AIR BRAKE PUMPS

Especially in summer the overheating of air pumps becomes a troublesome question alike to enginemen and repairmen. With the initial high temperature of the air on a hot, dry day, added to the heat gained during the process of compression, it requires considerable attention to the air brake system in general to prevent the air pump from being seriously overheated.

Among the most common causes of overheating are: Insufficient lift of air valves, air valves stuck or broken, loose intermediate valve seats cutting off lift or intermediate valves, leak at discharge pipe connection to air pump, or at main drum, air end rod packing blown out and racing of air pump.

These defects are easily located and, if promptly remedied, will prevent overheating and prolong the life and efficiency of the pump.

One defect frequently found is air end rod packing blowing. This reduces the efficiency of the pump to a considerable extent and is sure to result in overheating. This defect is often overlooked, especially if the steam end happens to be blowing at the same time.

Another thing that should not be overlooked in the care of an air pump is its proper lubrication. Do not flood the air end of the pump with oil, especially after it has begun to heat. Do not use engine oil, as it is not suitable for cylinder lubrication and will, in time, choke up the air passages, thereby destroying the efficiency of the pump. Oil sparingly at all times. Keep a good oil swab on the piston rods. Do not make the mistake of speeding the pump, for after a certain speed is attained the pump is working at its full capacity, and crowding beyond that will result only in overheating and failure.

BELT DRIVEN AIR COMPRESSOR

The half tone, Fig. 1, shows one of a line of simple power driven air compressors built by George S. Comstock, Michanicsburg, Pa., suitable for shop use or for any service when compressed air is required in comparatively small quantities and at the ordinary working pressures. Figs. 2 and 3 show the design and construction so that little description is necessary The two cylinders in a straight line and the crank shaft bearings are all integral with the frame or base, so that there is no possibility of are also in a straight line, and the scotch yoke principle employed for the drive gives a practically universal joint at the crank pin brasses. The cylinders are completely water jacketed and the splash lubrication guarantees the constant lubrication of all the working surfaces.

Fig. 3 is an enlarged section of the cylinder head showing the valve arrangement. *D* is the inlet and *E* the delivery. *A* is the inlet valve, and *B* the delivery valve, all being readily accessible. The central cover of the machine can be lifted off at any time giving roomy access to everything inside.

These compressors are made with one, two or four cylinders and with 8 different air capacities ranging from 6 to 140 cubic feet of free air per minute.

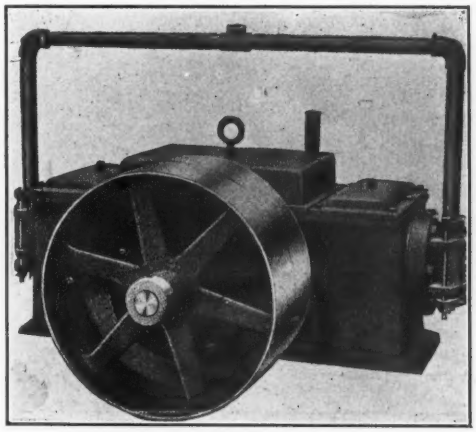


FIG. 1.

a small vacuum pump operated by a waterwheel using city pressure, and siphonic action occurs, filling the pipe and tank with water; the air pump is put out of action by a float regulator in the tank as the water rises in it. Air which accumulates during the operation of the siphon enters the tank, and consequently lowers the water level in it; the float, therefore, descends and the air pump is automatically started, exhausting the accumulated air. With this device practically no attendance is necessary.

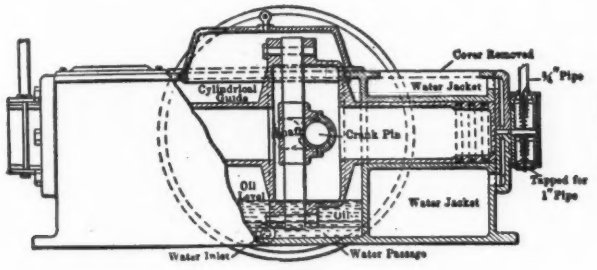


FIG. 2.

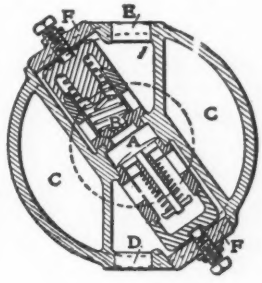


FIG. 3.

A SIPHON WATERWORKS

Siphonic action is the means by which water from fifty 2½ inch driven wells of the Woburn, Mass., supply is conveyed to the pit from which it is pumped into the distribution system. The wells are connected to the pump pit by a 14-in. cast iron pipe, which extends downward almost to the bottom of the latter. The high point in the line where air may collect is tapped by two 2½-in. pipes, which are connected to a closed tank at the pumping station. Air is exhausted from this tank and the pipe line by

A GUN'S WORKING LIFE FCUR SECONDS

What is the average working life of a gun? The answer is startling. The useful life of a gun of any size from a .303 rifle to the 13½ in. pieces for the new Dreadnoughts is approximately four seconds! The basis taken for this computation is the number of rounds fired and the time occupied by each round. A 12in. gun is destroyed by erosion after 100 rounds; the average mean velocity of its projectile is half the muzzle velocity, or say, 1200 ft. per

second. The length of the gun is 45 ft., and hence its total life 3.8 seconds. As we descend the scale of calibres the number of rounds that may be fired before erosion has destroyed the gun increases, so that the working life remains almost constant at about four seconds. This broad generalisation must not, of course, be taken too literally, as many varying factors may influence the result; but it serves, nevertheless to enforce the fact that the useful life of all guns is actually of the briefest. And the end of all is the same; be they large or small, it is the erosion of the bore that unfits them for further service. But erosion, like some wasting disease, is progressive—it begins with the first round that is fired, and before it has destroyed the sufferer it has greatly reduced its usefulness. The accuracy and range of the gun decrease as the erosion augments, and hence tables and scales, which are correct at the beginning of a fight, are wrong before the action is half over. It is not surprising then that the subject is one that has been profoundly studied, and that new investigations are always being made.—*The Engineer*, London.

A NOVEL STEAM BOILER

A steam boiler and furnace of peculiar construction, which requires no chimney, because the combustion gases are mixed with the steam which is admitted to the cylinders of the steam engine, have been in successful operation for some time on a Russian torpedo boat. Liquid fuel is used, and the combustion gases, which have an initial temperature of from 3,300 to 3,600 deg. F., have a temperature of about 1,800 deg. F. when they leave the heating surfaces of the boiler. The gases then enter a tube into which a fine spray of cold water is injected under pressure. The gases are thus cooled to between 650 and 900 deg. F., and the water is converted into superheated or unsaturated steam of the same temperature. The mixture of steam and combustion gases is conducted into the upper part of the boiler and flows thence, mixed with steam generated in the boiler, to the cylinders. In addition to dispensing with the chimney, the new boiler possesses the merit of very high efficiency, utilizing 90 and even as much as 97 per cent. of the heat produced by the combustion of the fuel.

PNEUMATIC CAISSONS FOR DRY-DOCKS IN QUICKSAND

The dry-dock construction in the Brooklyn navy yard is one of those complicated pieces of work which deserve to be described by a literary master like Kipling, for the struggle that is going on there between the treacherous quicksand and the men in charge of the work is something wholly outside the ordinary run of engineering undertakings. Every dry-dock in the yard has caused its builders constant worry, but the new one has a particularly cantankerous record of disaster. Those who are unacquainted with the site can hardly imagine the difficulties. The place is underlaid by very fine material possessing most of the characteristics of quicksand, although some engineers have hardly classed it as such. Whenever a large excavation is made in it subsidence occurs in the vicinity. The earlier contractors on the dock conducted the work in the open, and before they retired a number of buildings in the vicinity were injured by the settlement of their foundations. Attention has been called from time to time to the warning against such methods given years ago by the builder of the first dry-dock in the yard, the late William J. McAlpine. His experience showed him that it was impossible to execute more than a small piece of the structure at a time, but that the concrete could be put in piecemeal by concentrating the work on small areas. The new dock, after a long record of disappointments and tribulations, is now being executed in just this way, but by means which were outside the resources of Mr. McAlpine. The construction of such a dock is essentially a foundation problem, and the work is now being executed successfully by employing that most important resource of foundation specialists, the pneumatic caisson. This is essentially a means for concentrating construction on a small area under the most favorable conditions, and the work in progress in the Brooklyn navy yard is a singularly vivid exemplification of the progress in such matters since the first dock was constructed. That the troubles have by no means been wholly overcome is very probable, but enough of them have been encountered and bested to indicate that the new dock can be constructed without any more serious results to adjacent structures.—*Engineering Record.*

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STONE QUARRYING TO SPECIFICATION

In comparing the rate of production of a modern manufacturing establishment in almost any line of activity with that of one of the shops of the olden time, with its obsolete means and methods, the comparison always being of course for the magnification of the former, we are apt to omit some of the essential particulars, the omission leading us to unwarranted conclusions. A locomotive works, for instance, for a given force employed, will now turn out many times the number and value of engines which would have been possible half a century ago. Upon investigation it will soon appear that all the improvements in machine efficiencies and in the details of shop manipulation do not nearly account for the vast increase in output. Every shop in these days not only has its own force busily employed, but it also has many hands in many factories variously situated producing the minor details of the assembled machines which it turns out. Besides the enumerated force of workmen in the shop itself, there are probably many more than that number in other shops who are preparing material and manufacturing the numerous "supplies" which the shop requires and uses to complete its work.

This same distributing and specializing of activities, while concentrating their results, applies in larger enterprises than those of the shops. The greatest of all industries, is the building of cities, and none, perhaps, has had a greater transformation. The modern building methods are most rapid and prolific, because here the practice is now similar to that of the shops. The building of New York, for instance, is going on, not in New York alone, but in various places throughout the land. Practically all the vast structures which we are continually piling up higher and higher are really manufactured elsewhere, Manhattan witnessing only the final assembling of the parts. Most of the building of the skyscraper is done at the steel works, and at the stone quarry, and the several pieces, whether of steel or of stone, come already fitted and marked and numbered, to show how they go together.

In machine work, and all through the metal industries, the automatic screw machine, which as we all know, turns out a vast variety of small machine parts besides screws, is perhaps

the greatest individual helper, and in stone work the channeler finds equally wide employment, and accomplishment no less prolific.

The channeler emphasizes perhaps more completely than any other device the difference between ancient and modern practice in stone work. The channeler is not as yet capable of working some of the harder stones, but in the vast field which it does cover it represents the cutting of stone to precise dimensions.

We are quite in the habit of saying that Egyptian architecture called for massive blocks of stone, but the simple fact is that the method of quarrying produced big stones and the architect was compelled to adapt his designs to the material as it came to him. The quarries of Egypt even to-day tell clearly the story of the splitting off of the stones by the cutting of rows of holes of no great depth and the swelling force of the wooden blocks which tightly filled them. It is often said that we could not now get out and transport the stone masses of ancient Egypt. It simply would not pay and would not be worth while for us.

If we could not reproduce the temples of Thebes, still less could the builders of Thebes have produced the Metropolitan Life Building of New York, the largest marble structure in the world, and the most complete embodiment of the work of the channeler. After the Tuckahoe marble was decided upon for the material, the quarry could in no other particular dictate to the architect. The blocks in shape, dimension and detail of decoration were determined in the office, and the drills and channelers and pneumatic tools produced them precisely as ordered.

PNEUMATIC CAISSONS FOR RAISING THE MAINE

Mr. John F. O'Rouke, of the O'Rouke Engineering Construction Company of New York, has proposed to the War Department an application of pneumatic caisson methods for the raising of the Maine in Havana harbor. He proposes to raise the vessel in its entirety so that its holes can be patched and the ship be floated out of Havana Harbor. The scheme consists in sinking pneumatic caissons on both sides of the sunken vessel and between wharves previously constructed at the site. The caissons would be carried to a depth of about 10 feet below the bottom of the ship and through then steel cables of about 200 tons capacity would be passed at distances of 4 feet and carried beneath the hull of the vessel. The ends of these cables would be attached to screw jacks of at least 100 tons capacity, and by their operation, the vessel would be lifted from the bottom. The scheme for passing the cables beneath the hull is quite ingenious. The heavy lifting cable would be passed down through one caisson and immediately opposite each of these lifting cables, in the other caissons, a three-quarter-inch hauling cable would be placed. Small pipes would then be pushed through the bottom from one caisson to the other and through these the ends of the small cables would be passed to the opposite air chamber, after which the pipe would be pulled into that air chamber over the ends of the cables, leaving the latter exposed in the mud. The ends of the big cables would be attached to the smaller ones, hauled beneath the vessel and up to the top of the opposite caissons. By placing the lifting cables at distances of 4 feet, Mr. O'Rouke estimates that their combined strength would be four times the weight of the battleship. The framework supporting the lifting jacks would be built on the caissons, and, in order to prevent an excessive weight being thrown onto the foundations of the latter when the vessel is lifted, it is proposed to pump out the cofferdams above the caisson, thus making them buoyant. As the vessel is lifted it will be necessary, of course, to lower the jacks, in order to give them a new grip on the cables, and for this reason Mr. O'Rourke has provided a greater capacity than necessary, so that the jacks can be slacked off in pairs. He estimates that at least a thousand men would be required for operating the jacks.

ELECTRICTY vs. COMPRESSED AIR

Electrically operated construction equipment is steadily gaining in favor among contractors. It will be observed, however, that small electrically operated tools are rarely employed, for electricity is generally used simply as a convenient method of transmitting power from a source of supply of either permanent or temporary character to an air-compressor plant. Of course, electric hoists, electric railways and electrically driven machine tools are a frequent feature in construction camps, but small equipment, such as rock drills, churn drills, pumps and similar equipment, are still preferably oper-

ated by compressed air, in the opinion of most contractors. The reason for this is not far to seek. Construction equipment is subjected to a most grueling service. Dirt is present everywhere, often in the form of fine mud or very dry sand, the men in charge of the apparatus are generally unskilled laborers without sufficient intelligence to handle mechanism with delicate parts, and the location and maintenance of wiring, although apparently simple, has repeatedly proved a very troublesome matter, particularly on account of grounds. On the other hand, compressed-air machinery is as sturdy as anything made to-day. It has been developed by men who know all about its uses, and its operation is watched by their representatives for the express purpose of detecting every opportunity for improvement. The piping and connections can be made readily, and the average workman can keep them in condition more easily than electric wiring.—*Engineering Record.*

COMPRESSED AIR FOR HANDLING WET CONCENTRATES

At Cananea, Mex., the wet concentrates from the Cananea Consolidated mill are loaded into small, narrow-gage railroad cars and transported to the main ore bins. From these bins they are fed to a belt conveyer which passes through the sampling works to the mixing beds.

A simple device has been introduced, as described by Mr. M. J. Elsing in a recent issue of The Engineering and Mining Journal, which greatly reduces the cost and the labor of handling this wet material. From the jarring and the settling received in the railroad cars, the wet concentrates become so firmly packed that even after the bottom of the car has been released, the concentrates will not fall from the car. Formerly it was necessary for two men to do considerable barring in order to dislodge the concentrates and empty the car. A compressed-air device is now used which saves all barring.

The device consists of a 1¼-in. pipe, approximately 9 ft. long, with a short piece of pipe attached which is pointed at one end with a hole in it about ¼ in. in diameter. The short piece is attached with an ordinary pipe coupling. At the other end of the long pipe there is a valve attached and an ordinary air hose. This is then connected with an air main under a pressure of from 80 to 90 pounds.

With this device a Mexican stands on each end of the railroad car, thrusting the pointed end well toward the bottom of the loaded car, and turns on the air. The result is that with a small amount of barring with this device the car is quickly unloaded. The concentrates are literally blown out. Formerly it took from one to 1½ hours to unload a train of from six or seven cars. It is now done in about 15 to 20 minutes.

The device is again used in feeding the concentrate from the steel bins to the belt conveyer. A steady feed is obtained with the expenditure of only a small amount of air and labor.

FREEZING OF PUMP EXHAUSTS

The exhaust of a pump operated by compressed air will not ordinarily freeze if the air outlet be of large size, but often pumps which have been designed for operation by steam are connected with the compressed-air line in the mine, and such pumps are more than likely to freeze at the exhaust. This can be prevented if the main water-discharge column be tapped about 10 ft. above the pump and a ¼-in. pipe be inserted, this small pipe to be extended to the air exhaust of the pump, and the end of the pipe drawn down to about one-sixteenth inch. The jet of water from this little nozzle should be directed into the exhaust opening, when it will be found that the exhaust will not freeze. In some cases it is sufficient to allow the stream of water from the little pipe to merely drip down on the exhaust port of the pump.

With the best modern compressed air practice, where aftercoolers are provided near the compressors, with separating chambers farther along the line where the water dropped by the air may collect and be drawn off, the freezing of pump exhausts is practically unknown.

CAPACITY OF THE HORSE

Eudurance is the horse's weakest point. Ten hours a day is often assumed as his working period. Authorities claim that eight hours is better, or that six under a heavier load will accomplish the same volume of work with less tear and wear on the horse. The average farm horse cannot be depended upon for more than 13 to 15 miles of pull a day, nor more than four to six hours of work per day, as an average of even the busiest months. Properly han-

dled working about six hours a day, well and carefully fed, a horse may have a working life of ten years of 1,000 hours each. The average farm horse will do well to develop 500 horsepower hours per year or 5,000 in ten years. About 20 per cent. of the horse's weight may be taken as his maximum sustained draft, and six to eight miles per hour his maximum sustained speed for anything more than an hour or so per day. The draft horse ordinarily gives the largest volume of work per day at about one-half his maximum load, and one-third his maximum speed.

BUREAU OF MINES

The new Bureau of Mines, of the Department of the Interior, will devote itself first and principally to the investigation of mine accidents, a work which has heretofore been carried on under the Geological Survey. For this purpose and for the investigation of fuels, Congress appropriated $410,000, and the total appropriation for the Bureau is $502,200. In general, the Bureau will continue the work of the Technologic Branch of the Geological Survey, and the work will be done largely by the same men heretofore engaged in the work. Many of the problems before the Bureau will have to wait, however, until Congress makes further appropriations. The director of the Bureau is George O. Smith. Bulletins on analyses of coal and other subjects will be issued by the Bureau before long. The director's office is at Washington, but the Bureau includes the testing station at Pittsburg, and resue stations will be established at a number of points in the coal regions.

MINING TUNNEL SCHEMES

As an investment, long tunnels driven solely for the purpose of cutting unknown veins or veins of unknown depth which outcrop at the surface, are rather risky undertakings, the chances for losing being far greater than those for winning. Veins that look promising at the outcrop may be found to have narrowed at depth or pinched out entirely. It would be far more profitable to sink on them than to do a great amount of dead work until their value and permanence has been proved. Driving in the hope of cutting unknown veins is absolute folly. Such schemes may appear plausible to the inexperienced, when presented by a silver-tongued promoter, backed by maps and sketches of underground conditions as they exist in his imagination only. It is a safe rule to let such schemes alone.

This does not apply, however to another class of tunnel schemes, where the primary object of the tunnel is not to cut veins, but to afford main haulage roads communicating with an important proved mineral area and to provide a cheap means for taking out a large tonnage of ore, or to afford drainage for a large number of mines. Such tunnels are the Newhouse, Yak and Roosevelt in Colorado, the Sutro in Nevada, etc. Tunnels of this kind may disclose valuable ore bodies which can be opened through them, and prove sources of profit, but this is merely incidental. There is no gamble in such undertakings, as the benefits to be expected from them can be closely estimated before the work is undertaken.—*Mining World.*

AN IMPROVED ANEMOMETER

A new form of anemometer for recording separately the components of the wind motion in two fixed rectangular directions, such as the north-southerly and the east-westerly, is described by J. T. Morrison in the proceedings of the Royal Society of Edinburgh. The novel feature of this instrument is a sphere, mounted on a horizontal axis, the latter being moved in a horizontal plane by a wind vane so as to lie always parallel with the direction of the wind. The sphere is connected, by suitable gearing, with a wind wheel exposed to the wind, and rotates with it, its rotation corresponding to the total movement of the wind. The latter is analyzed into two components by means of two beveled discs, mounted on vertical axes, and pressing the sphere at their edges, so as to be turned by it with speeds and directions varying according to the position of the sphere. The center of one disc lies east and that of the other north of the center of the sphere. The discs actuate separate pens that trace curves making a continuous record of the two rectangular components of wind-movement.

CONSULTING A DIVINER TO AVOID WATER TROUBLE

An interesting application of the water diviner's art has been made at Daggafontain, where the services of Mr. Collyer, the expert, have been employed to indicate the spot on the property where the proposed shaft would be least likely to suffer from water troubles.

Throughout the whole Far East Rand basin water is giving trouble, and the experience of the Grootvlei people, where many thousands of gallons per day have had to be dealt with, points to the necessity for doing everything to avoid the underground springs which seem to abound in the neighborhood. On the Daggafontain Mr. Collyer has indicated a spot where a shaft, in his opinion will be free from all but ordinary soakage water, and should his prediction be fulfilled no doubt his assistance will be invoked as a preliminary to shaft sinking on other properties in water carrying districts.—*South African Mining Journal.*

LACK OF OXYGEN IN HYDRAULIC AIR AT COBALT

When the air from the hydraulic air compressing plant at Ragged Chutes, Cobalt district, Ontario, was first turned on it was found that it was practically impossible to burn candles in the mines where it was used. It was claimed that this was due to the absorption of oxygen by the asphalt with which the inside of the pipes were coated, and that this effect would soon pass off. It was soon found, however, that hydraulic air contains an appreciably less percentage of oxygen than ordinary air, and analysis demonstrated that it contained only 17.7 per cent. oxygen, which is 3 per cent. lower than ordinary air. This is due to the oxygen going into solution in the water during compression, when a pressure of 130 to 135 lb. per sq. in. is maintained. The lack of oxygen does not apparently trouble the miners, but besides the difficulty experienced in keeping lights, the effect of the gases from exploded dynamite is much quicker and more serious than was found to be the case with air compressed by machinery.—*Engineering and Mining Journal.*

USINC ANEROID BAROMETERS

Aneroid barometers possess peculiarities which must be known for each instrument in order to employ them with safety. Without such knowledge even the indicated difference of altitude between two near-by points, which may be reached before temperature and moisture conditions in the atmosphere can have changed, is not to be trusted. Each instrument is generally reliable within certain limits of altitude, one being safe at low levels, another at moderate elevations, and so on. No aneroid barometer should be used for serious reconnoissance leveling until it has been thoroughly tested under partial vacuums corresponding to the atmospheric pressures at different elevations above sea level. No aneroids possess a constant error throughout the range of pressures they are supposed to record. Furthermore, the errors once determined will not apply throughout the life of the instrument, this being due apparently to gradual relief of strain between the molecules in the corrugated metal plate. If an aneroid can be tested against mercurial barometers within the limits of altitude in which it is intended to work, it is better than to trust to the air pump.

NOTES

The Lehigh Valley is to tunnel Bear Mountain at Mauch Chunk at an expense of $1,000,000. A short cut of one mile is now to be gained.

Explosive mixtures of alcohol vapor and air can be compressed to much higher pressures in an engine cylinder without pre-igniting than can explosive mixtures of gasoline vapors and air.

In California it has been demonstrated that in thermal units two and a half barrels of oil equals one ton of coal. Coal costs there from $6 to $8 per ton wholesale, while the market delivery price of oil is $1 a barrel.

The Prussian State Railways have recently installed an apparatus in which a complete coach can be heated by steam and subjected to a vacuum, with the object of drying it, and destroying vermin. The process occupies about ten hours, and costs approximately $5.

On the Denver and Rio Grande Railroad recently an entire train, locomotive and eight cars, going at a high speed left the track and ran along for a distance on the ties without anything turning over or anybody being hurt by even a scratch. Near the place is a bridge where a hundred lives were lost a few years ago.

The short but dangerous rock tunnel of the Jersey Central at Glen Onoko is to be removed by blasting away the entire mountain cliff of stratified rock through which it was built. The

cost of the work will be about $1,000,000 and is considered preferable to building a bridge over the river, which would probably be fully as expensive and is the only way in which the road could get around the mountain.

Commissioner Moore's recommendation that that section of the patent statutes which provides for the filing of caveats be repealed, has been acted upon by Congress and the President. Henceforth there will be no more caveats in the United States. An application for a patent does all that a caveat can do, and more.

And now the aeroplane has come down to carrying freight. A. M. Williams, an aviator of Douglas, Arizona, has contracted to convey placer mining machinery from Douglas to the property of Dr. J. J. P. Armstrong in the mountains of Chihuahua, Mexico, a distance of 300 miles, the route being practically inaccessible for teams. Pieces or packages weighing up to 100 pounds are to be carried.

At the foundry of the Fort Wayne Electric Works rain water in a closed piping system is circulated through the water jackets of the air compressors by a plunger pump driven from the compressor shaft, replacing a constant flow of city water. The circulation starts when the compressor starts and stops when it is shut down. Tubular automobile radiators keep the water cool.

As a matter of cold fact, pending patent applications are the only valid excuse for withholding from publication the description of anything new. When there is no element of this kind involved a manufacturer's attempt at secrecy almost always indicates either that he is pitiably small-minded and conceited or that he is afraid to submit his designs to the critical consideration of the engineering public.—*Power and the Engineer.*

In California there are many large dredges in use costing as high as $150,000 to $300,000. The average life of these dredges, which seems to be determined by that of the hull, is from eight to ten years, while if proper means are not employed for the prevention of dry rot a hull will go to pieces in four or five years. On a dredge of the Natomas Consolidated of California, operating in the American River field, artificial ventilation is being tried. Air is forced into the hull by a fan blower, starting at one end, the intermediate hatches being battened down so that circulation is secured throughout the entire length.

In the scientific sense an ore is a metalliferous mineral belonging to the group of those which have profitably yielded the metals to the miner or metallurgist. In its technical sense an ore is a metalliferous mineral or an aggregate of metalliferous minerals, more or less mixed with gangue and capable of being, from the standpoint of the miner, won at a profit; or from the standpoint of the metallurgist, treated at a profit.

Juan Antolin, a Spanish laborer, aged 38 years, was washed through 269 ft. of 20-in. drain pipe at Gatun Dam on the afternoon of July 4, and is recovering from the bruises he sustained. He was one of a gang at work on a floating platform keeping debris, from the hydrauic fill in the west section of the dam, from being carried into the drain pipe and clogging it. He fell from the platform and, although his fellow workers tried to rescue him, was carried head first into the pipe. A minute later he was washed out of the discharge end of the pipe into the old West Diversion channel whence he swam and was dragged ashore.—*The Canal Record,* July 13, 1910.

The Knox system of blasting is used in quarrying, and consists in drilling two holes in the rock, these holes being located along the line where a fracture is desired, and about 1 foot apart. Black powder is charged in the hole, the quantity being determined by the size of the rock mass it is desired to split off. Tamping is put in the hole, but is not placed in contact with the powder, a space of 1 to 3 feet being left between tamping and powder. This affords an air cushion, which in part receives the shock of the blast. The holes are fired and recharged several times the result being the fracture of the rock along a line corresponding to the direction of the holes.

A young woman student in the Engineering Department of the University of Michigan, announces that she intends to make a specialty of sewer contracting. She says: "Why shouldn't there be just as much opportunity for a girl

to win success building sewers as in writing stories, teaching school, doing sociological work or lecturing on woman's suffrage." We wish her all success, but she may find that the qualification requirements are quite different in sewer constructing from those in the other avocations she specifies.

Boilers may be, and in fact have been, hydraulically tested for pressure without the use of a pump. The cold boiler must be filled completely with cold water, leaving no air anywhere. Then build a small fire under the boiler, not to generate steam but just to warm the water. Its expansion will immediately begin to cause pressure, which will show at the pressure gage. When the test pressure is reached open a try cock and if everything is all right the water may be discharged at the blow-off until it is at the proper level for raising steam.

Calypso's Island has been moved to South Bethlehem, Pa., by dredging it out of the center of the Lehigh River by direction of the engineering staff of the Lehigh Valley Railroad, and the material, 125,000 cubic yards of stone and earth, has been used to fill in an arch-like curve that the right bank of the river makes just west of South Bethlehem. The object of the removal of the island is to straighten the road and to get space for four tracks in addition to room for building sidings.

Compressed air for cleaning the electric machinery in all parts of the filtration building of the Cincinnati water purification works has been made available by the installation of a motor-driven compressor and a small air receiver in the pump room of the head-house. From the receiver a 1-in. pipe line, with suitable outlets, was run through the pipe gallery of the filter house and into the chemical house. A flexible hose attached to outlets on the line permits the electric equipment to be cleaned readily.

To ascertain the weight of dust contained in a given volume of air, a chloride of calcium tube containing perfectly dry absorbent cotton is weighed accurately and then attached to a water suction pump with an air meter between. A large amount of air, say, 18 or 20 cubic feet, is then drawn through as quickly as possible, and when a sufficient amount has passed, the tube is detached and placed either in a drying oven or in a desiccator over sulphuric acid, and kept until it ceases to lose weight (moisture). After this operation the net increase in weight represents the amount of dust in the volume of air aspirated.

The French government has finally decided not to adopt aluminum coinage. A certain number of aluminum coins were made as a test, but the lightness of the white metal, which was one of its chief recommendations, has condemned it. A five-centime piece (one cent) made of aluminum weighed only 1.9 grammes, as against 5 grammes in bronze, and it is thought that a coin so light would slip through the fingers, especially the rough fingers of a workman. Tests are now to be made of bronze containing 10 per cent. of aluminum, which, if adopted, will reduce the weight by one-half. This combination of metals possesses a fine golden yellow colour, and the coins made of it will therefore be perforated so that they may not be mistaken for 20-franc pieces.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JULY 5.

963,049. APPARATUS FOR REMOVING DUST. DAVID T. KENNEY, North Plainfield borough, N. J.

963,139. PNEUMATIC SUCTION-CLEANER. DANIEL D. GRIFFITHS, New Madrid, Mo.

963,244. PROCESS OF STERILIZING MILK. CASSIUS CLAY PALMER, Cranford, N. J..

963,359. WIND-TURBINE. JOSEPH GERSHOM CHILDS, Willesden Green, London, England.

963,407. EGG-SHELL REMOVER. ANTON UHLIR, Charleston, W. Va.

2. In an egg-shell remover, in combination, a chamber for receiving one portion of an egg, means to perforate the shell thereof and means to compress air in said chamber.

963,465. AUTOMATIC RAILWAY AIR-BRAKE. WILLIAM K. OMICK, Detroit, Mich.

963,487. COMBINED AUTOMATIC AND STRAIGHT-AIR BRAKE APPARATUS. WALTER V. TURNER, Edgewood, Pa.

963,606. PNEUMATIC SHOCK-ABSORBER. ALBERT MANS, Dieghem, Belgium.

963,641. DEVICE FOR PUMPING LIQUIDS. FREDERIC H. PARKE, Edgewood, Pa.

963,662. AUTOMATIC CONTROL FOR PRESSURE APPARATUS. HENRY F. THOMA, Sand Coulee, Mont.

963,676. AIR - COMPRESSOR. WILLIAM WRIGHT, Adamsville, Ala.

963,701. VACUUM-CLEANER. ERIC ERICSSON and ERIC G. THOREEN, Worcester, Mass.

963,723. VACUUM CLEANING APPARATUS. EDWARD WALLACE PIERCE, Philadelphia, Pa.

JULY 12.

963,767. METHOD OF CLEANING AND STERILIZING FILTER-STONES. HAROLD JARVIS, Buffalo, N. Y.

3. The herein described method of cleaning a water filter stone which consists in forcing air through the pores of said stone from the delivery side to the supply side thereof while the latter side is immersed in hot water and then drawing said hot water through the pores of the stone from the supply side to the delivery side thereof.

963,759. VACUUM-PAN APPARATUS. JOHN A. GROSHON, New York, N. Y.

963,787. MINE-VENTILATING SYSTEM. DAVID R. MARTIN, Opelika, Ala.

963,788. AIR-COMPRESSOR. FRANK HEATH MERRILL, Plainfield, N. J.

963,803. COMBINED GOVERNOR AND REGULATOR FOR AIR-COMPRESSORS. JOHN L. OSBORNE, Erie, Pa.

963,829. HUMIDIFYING APPARATUS FOR DWELLING-HOUSES. ALBERT W. THOMPSON, Manchester, N. H.

963,832. APPARATUS AND PROCESS FOR CONTROLLING HUMIDITY OF GASES IN DRYING OPERATIONS. HARRY D. TIEMANN, Washington, D. C.

963,923. AIR-PUMP. GEORGE MCKERAHAN, Altoona, Pa.

963,924. ATTACHMENT FOR PNEUMATIC HAMMERS. CHARLES MCSHERRY, Pittsburg, Pa.

963,973. PROCESS FOR INTRODUCING MODIFYING ELEMENTS INTO CASTINGS. FRANK G. WRIGHT, Indiana Harbor, Ind.

The process of introducing a modifying element into a cast body during pouring into the molds which consists of directing a blast of air containing the element in the form of a powder in a downward direction into the stream of heated metal as it enters the mold.

963,981. AUTOMATIC PNEUMATIC MUSICAL INSTRUMENT. ERNEST WILLIAM BATTEN, Herne Hill, London, England.

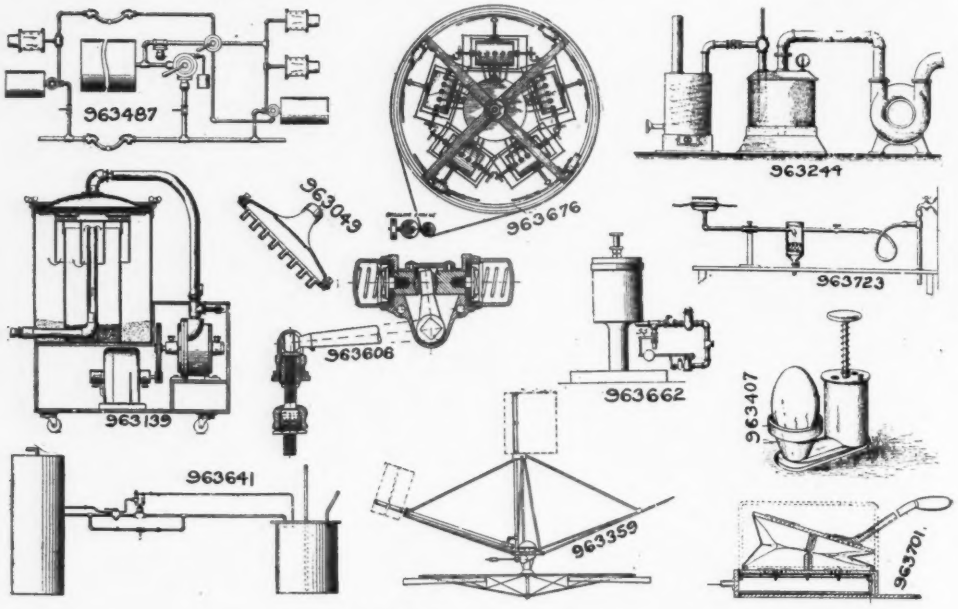
964,013. PNEUMATICALLY - OPERATED STRING INSTRUMENT. ROBERT FROMSDORF, Leipzig-Eutritzsch, Germany.

964,949. PNEUMATIC TIRE. MILTON T. J. OCHS, Allentown, Pa.

964,168. CONTROL DEVICE FOR AIR-BRAKE MECHANISMS. CAMILLE LANG, Wilmington, Del.

964,373. CAR-VENTILATOR. ALFRED BEST, Salt Lake City, Utah.

964,377. AIR-FILTER. WALTER BLASS, Essen, Germany.



PNEUMATIC PATENTS, JULY 26.

JULY 19.

964,485. FLUID-BRAKE. FRANZ BOMINGHAUS, Essen-on-the-Ruhr-West, Germany.

964,492. OXYGEN-GENERATOR. MONROE S. CLAWSON, New York, N. Y.

964,574. MEANS FOR INCREASING THE ENERGY OF STORED COMPRESSED AIR. WILLIAM HORACE SODEAU, Newcastle-upon-Tyne, England.

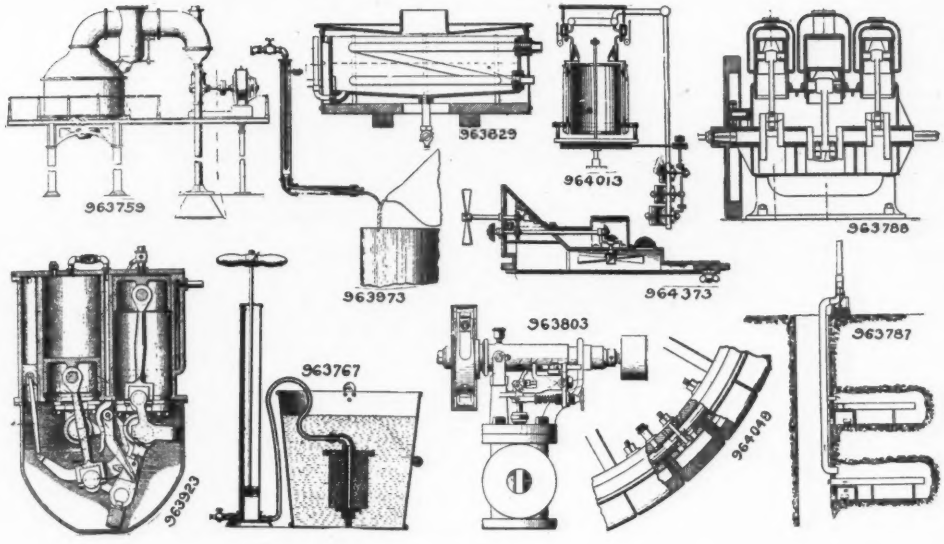
1. Means for increasing the energy of stored compressed air comprising in combination a combustion chamber, a conduit leading compressed air to said combustion chamber, a receptacle for liquid, means leading from said receptacle to said combustion chamber and means connecting said receptacle with the compressed air conduit, said means having an opening in the conduit facing toward the oncoming air whereby the kinetic energy of the air stream in the conduit produces a pressure in the liquid receptacle in excess of that in the air conduit and combustion chamber.

964,605. FEEDING MECHANISM FOR ROCK-DRILLS AND THE LIKE. GEORGE R. BENNETT, Denver, Colo.

964,639. PNEUMATIC CLUTCH. JAMES C. GARRETT, Jersey City, N. J.

964,717. PROCESS OF SEPARATING DUST AND OTHER MATERIALS FROM DUST-LADEN AIR AND A DUST-COLLECTOR FOR CARRYING OUT SAID PROCESS. CHARLES F. VERRELL, Grand Rapids, Mich.

964,771. AEROPLANE. SAMUEL H. GILSON, Salt Lake City, Utah.



PNEUMATIC PATENTS, JULY 19.

964,800. SUCTION-NOZZLE. JACOB C. LUDEN, Reading, Pa.

964,805. APPARATUS FOR PRODUCING CEMENT. HERMANN PASSOW, Blankanese, Germany.

964,866. FLUID-PRESSURE MOTOR. ROY C. JENNER, Detroit, Mich.

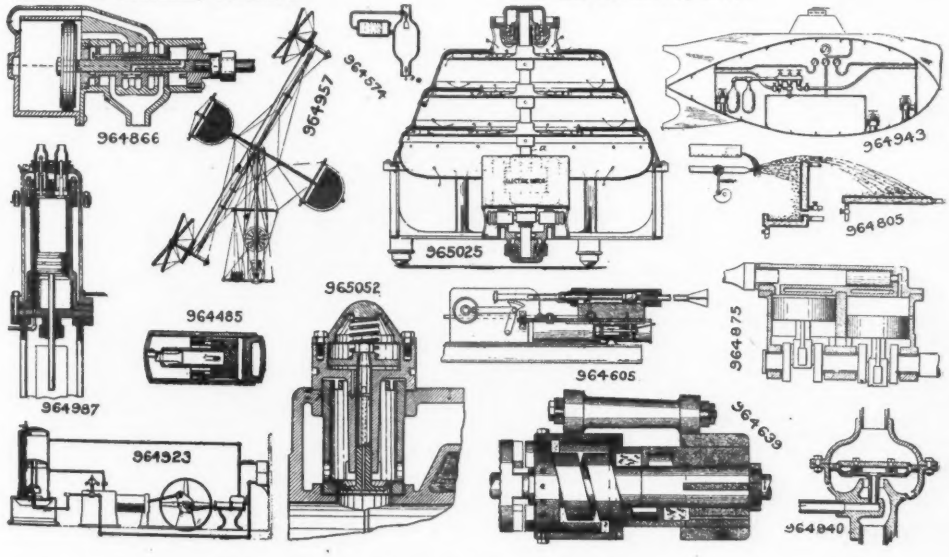
964,875. ROCK-DRILL. HARRY JOHAN HJALMAR NATHORST, Gellivare Malmfalt, Malmberget, Sweden.

964,921. AIR-HEATING SYSTEM. SIMON S. LAUGHLIN, Colwich, Kans.

964,923. POWER-GENERATING APPARATUS. FRANK W. LIERMAN, Milwaukee, Wis.; Augusta Lierman, executrix of said Frank W. Lierman, deceased.

A pressure-fluid generator comprising an upper and a lower chamber, the upper one being an air chamber and the lower a combustion and expansion chamber, means for supplying air to said air chamber, a burner in the lower part of said combustion chamber, means for supplying fuel to said burner, a hood overhanging said burner, a connection between said hood and said air chamber adapted to direct a blast of air upon said burner, and an outlet in said combustion chamber at a point remote from said burner, for the mingled air and products of combustion.

964,940. DUST-SEPARATING OR VACUUM CLEANING APPARATUS. LEMUEL WILLIAM SERRELL, Plainfield, N. J.



PNEUMATIC PATENTS, JULY 12.

964,943. MEANS FOR EMPTYING SUBMERGENCE-TANKS IN SUBMERGIBLE BOATS. LAWRENCE Y. SPEAR, Quincy, Mass.

1. In a submarine or submergible boat, a plurality of submergence tanks including tanks discharging under high pressure and tanks discharging under low pressure, a single fluid pressure system connected to the several submergence tanks for expelling the water therefrom, and means for indicating the pressure in each tank, whereby danger of exploding the low pressure tanks is avoided, substantially as described.

964,957. FLYING-MACHINE. HALVOR OLSEN EIANE, U. S. Navy.

964,987. COMPRESSOR. JOHN T. LOVE, Charlotte, N. C.

965,021. FLYING-MACHINE. HANS SCHOUBOE, Omaha, Nebr.

965,025. VACUUM-PRODUCING APPARATUS. LEMUEL WILLIAM SERRELL, Plainfield, N. J.

965,052. COMPRESSOR AND VACUUM-PUMP VALVE. CHARLES WAINWRIGHT, Erie, Pa.

965,120. GOVERNOR FOR AIR-COMPRESSORS. GORY O'BRYAN, Louisville, Ky.

965,310. PNEUMATIC STACKER. WALLACE F. MACGREGOR, Racine, Wis.

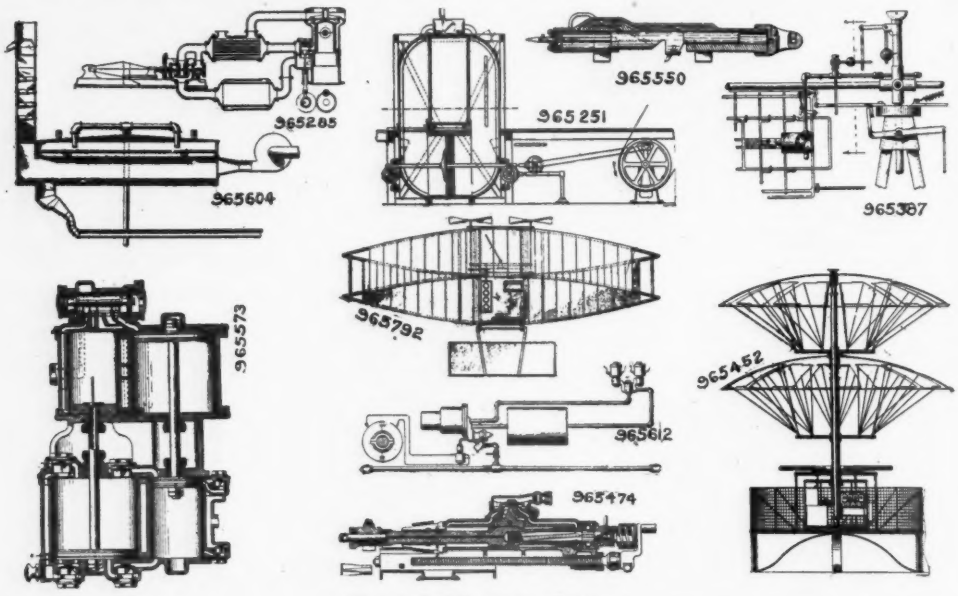
965,387. WINDMILL. HENRY I. HAWXHURST, Los Angeles, Cal.

965,452. FLYING-MACHINE. FRED LINCOLN GOULD, Reno, Nev.

965,474. ROCK-DRILL. EDWIN M. MACKIE and PERCIVAL F. DOYLE, Franklin, Pa.

965,494. SENDING-TERMINAL FOR PNEUMATIC - DESPATCH - TUBE SYSTEMS. FRANKLIN H. WOLEVER, Chicago, Ill.

965,550. AUTOMATIC TOOL-OPERATING DEVICE. JOHN M. ABRAMS, Bentley Manor, N. Y.



PNEUMATIC PATENTS, JULY 5.

JULY 26.

965,208. SURF COMPRESSOR APPARATUS. JOHN LEVERING MATTHEWS, San Diego, Cal.

965,251. PROCESS OF DRYING GOODS. LUDWIG VON SUSSKIND, St. Georgen, near St. Gallen, Switzerland.

2. The herein described process of drying moist substances consisting in compressing air in a closed chamber containing the substance to be dried, dividing the volume of air into two streams according to the degree of dryness required, causing one stream to pass through the substance to be dried and causing the other stream to follow a parallel path and to overcome an adjustable resistance, regulating the temperature and dryness of the second stream, and reuniting the said streams.

Chicago, Ill.

965,281. PNEUMATIC TIRE. JOHN CORWIN.

965,285. APPARATUS FOR TRANSMITTING POWER. JAMES DUNLOP, Dennistoun, Glasgow, Scotland.

1. In apparatus for transmitting power by means of compressed air, the combination of an air compressor and a compressed air motor connected together in a closed circuit, an engine for driving said compressor, a crank shaft for said compressor, a valve shaft for said compressor, a valve for said compressor connected to said valve shaft, and manually operable means for varying the angular relation of said valve shaft and said crank shaft and thereby varying the time of movement of the valve.

965,573. COMPOUND STEAM PUMPING-ENGINE. ALEXANDER ENGLAND, Wilkinsburg, Pa.

2. In a compound pumping engine, the combination with high and low pressure engine cylinders having pistons therein, of an initial compression pump cylinder having a piston directly connected to the high pressure steam piston, a smaller final compression pump cylinder having a piston connected to the low pressure steam piston, and a valve mechanism operated by the movement of the high pressure steam piston for effecting the admission and exhaust of steam to and from the engine cylinders.

965,604. PASTEURIZED - CREAM COOLER AND AERATOR. EDWIN S. SNIVELY, Omaha, Nebr.

965,682. AIRSHIP. LEONIDAS HAMLIN BARRINGER, Charleston, W. Va.

965,612. DUPLEX AIR-BRAKE SYSTEM. WALTER V. TURNER, Edgewood, Pa.

965,783. VACUUM CLEANING APPARATUS. THEODORE WIEDEMANN and JOSEPH H. TEMPLIN, Philadelphia, Pa.

965,792. AEROPLANE. LOUIS R. ADAMS, New York, N. Y.

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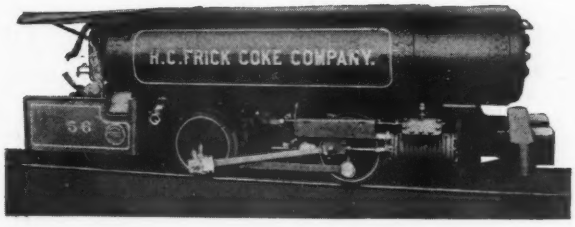

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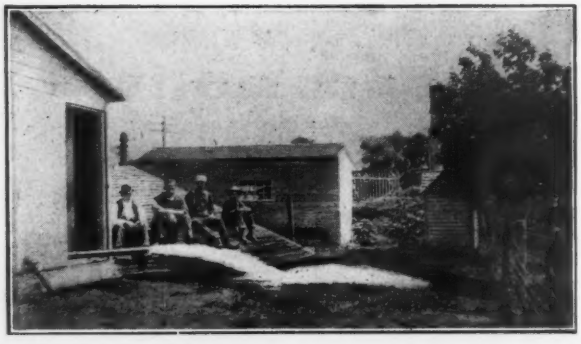

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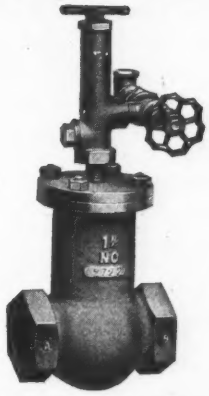

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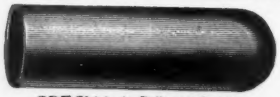
TANKS  TANKS

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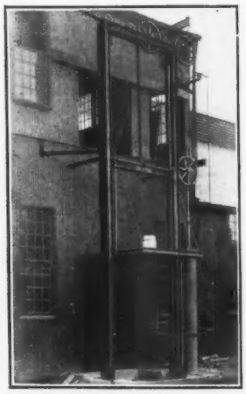

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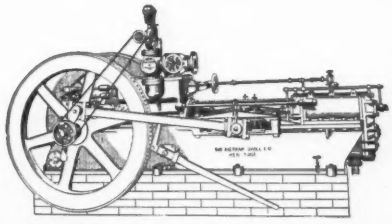

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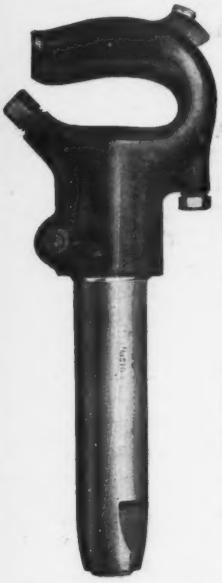

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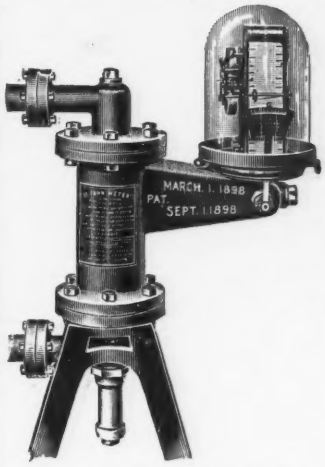

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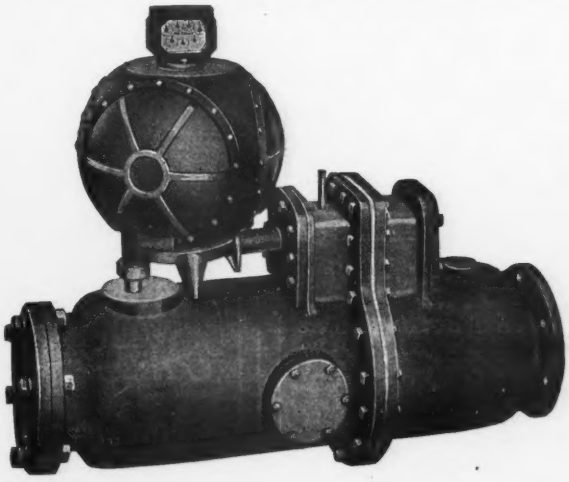

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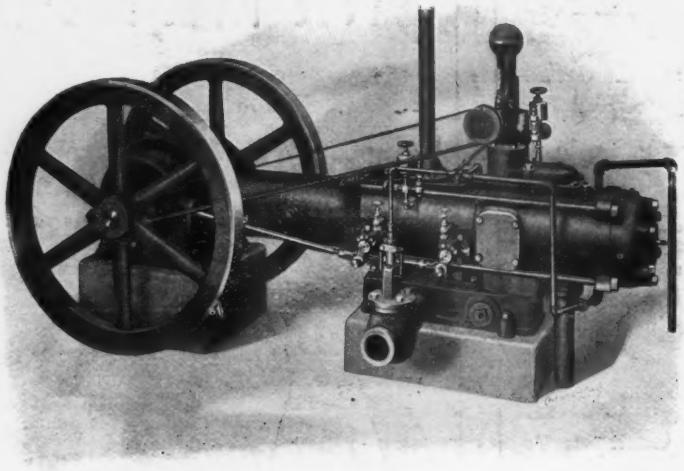

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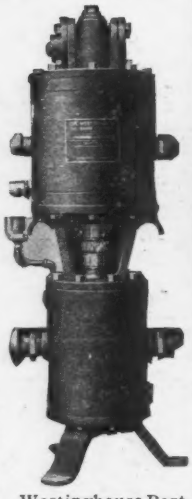

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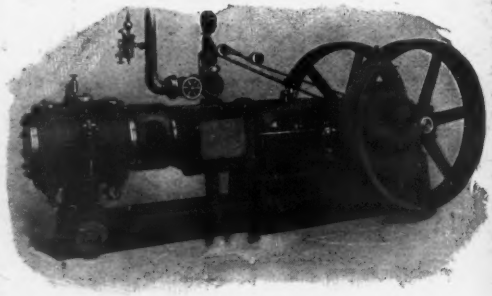

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